

3. Program Plan

3.1. Program Administration:

3.1a: Program Director: Rakesh P. Patel Ph.D, Professor of Pathology, Director of the Cellular and Molecular Pathology Graduate Program, Director of the HHMI-UAB Med into Grad Program and Co-director of the GBS Pathobiology and Molecular Medicine theme will serve as Program Director. Dr Patel will be responsible for scientific leadership, fiscal matters, and overseeing administration of the training grant including monitoring the progress of the students, prepare progress reports, evaluations and manage recruitment and appointments of trainees with input from the steering committee.

Dr. Patel's research program is focused on understanding how reactive species and specifically nitric oxide regulate inflammatory diseases including those of the cardiovascular, pulmonary, renal and hepatic systems and use insights gained to develop and test therapeutics. We use an interdisciplinary approach that encompasses basic science and translational / clinical trial studies. Our current research portfolio includes i) understanding how red cells affect nitric oxide metabolism in the context of lung injury and transfusion related toxicity in trauma patients, ii) how endothelial N-glycans control the process of leukocyte adhesion and atherogenesis iii) how nitric oxide based therapies may be used to limit ischemia-reperfusion in human liver transplantation and prevent inhaled toxicant induced lung injury. He received his PhD in Biochemistry in the UK at the University of Essex, with his interest in biomedical and translational research starting then also, especially during the 1 year period he spent at Wellcome Research Laboratories in London; Dr Patel was a recipient of a Case studentship that allowed him to spend a significant amount of this dissertation research time in industry. With respect to this training program proposal he has incorporated this experience in the industrial sector by integrating training in management and the related personnel skills necessary to participate in the multi-disciplinary research teams that characterize the modern translational academic research environment. Dr Patel moved to UAB in 1997 to start a postdoctoral fellowship in Free Radical Biology and upon its successful completion, remained at UAB and since moved up the ranks to full professor (in 2010) and established an independent NIH and industry supported research laboratory. He has published >160 publications and has an H-index of 51 (as of May 2014). He has served on NIH study sections including for Minority research grants, serves on numerous editorial boards, and is an Associate Editor of AJP-Lung Molecular and Cellular Physiology (since 2012). He is a member of the UAB Comprehensive Cardiovascular Center, Center for Free Radical Biology, Nephrology Research Training Center, Diabetes Research Training Center, Center for Exercise Medicine, Nutrition Obesity research center and the Center for Clinical and Translational Sciences. A consistent and overarching theme of his research is the integration of translational biology with biochemical and mechanisms oriented studies. This ranges from assessment of key concepts supported by pre-clinical experimental (test-tube biochemistry, cell culture or animal studies) with human samples, evaluating mechanisms in humans either non-invasively (e.g. blood flow and tissue perfusion in Trauma patients) or invasively (e.g. evaluating inhaled nitric oxide as at therapy to mitigate ischemia-reperfusion therapy in liver transplantation via blinded, placebo controlled clinical trials). Dr Patel has published expertise in all elements of translational research including applying for IND from the FDA and phase 1 and 2 studies. In addition to the above, other ongoing translational projects include safety studies evaluating nitrite as donor for nitric oxide in peripheral arterial disease patients as well as in the context of inhaled toxicant injury. In parallel, Dr Patel has a strong commitment to education and training, especially pre-doctoral students. *To date 5 PhD students have graduated from his laboratory with an average time to degree of 4.4 years.* This commitment is further reflected by his roles as program director of the Department of Pathology Graduate Program, Co-Director of the Pathobiology and Molecular Medicine Graduate theme, and Director of the HHMI-UAB Med into Grad predoctoral program He is also played a consistent role in graduate teaching and mentoring serving on a total 34 student dissertation committees (31 at UAB, 3 external) over the last decade. Collectively, this reflects Dr Patel's expertise and ongoing commitment to training the next generation of scientists and integrating translational research into pre-doctoral student training paradigms. His effort associated with this application is 10%, but salary is not requested.

Associate Director: Dr. Namasivayam Ambalavanan MD, Professor of Pediatrics, will serve as Co-Director. Dr. Ambalavanan is a physician-scientist who is board certified in Pediatrics and Neonatal-Perinatal medicine. He completed medical school (1988) and a pediatric residency (1993) in India, followed by a neonatology fellowship combined with a pediatric residency at the University of Alabama at Birmingham in 1997. He has been a full Professor of Pediatrics with tenure at UAB since 2010, and is the Director of the Division of Neonatal Research, as well as the Director of the Neonatal-Perinatal Medicine Fellowship Program. He manages the Sergio Stagno Research Endowment. He founded the Translational Research in Normal and

Disordered Development (TRenDD) program at the University of Alabama at Birmingham in 2009, which is an interdisciplinary program of research and education, focused on disorders that affect the development and maturation of tissues and organ systems in late gestation and infancy. The goal of this program includes the support of collaboration through state-of-the-art seminars, access to critical core facilities, and administrative support for multi-investigator projects, and to promote excellence in training and education of basic and clinical investigators. Dr. Ambalavanan's research interests include basic science and clinical / translational projects. Clinical and translational research expertise includes neonatal nutrition (specifically vitamin A and D), feeding practices, probiotics, biomarkers, and prediction of clinical outcomes. He directs single center and multicenter observational and interventional clinical studies. UAB is a regional perinatal center with approximately 350 very low birth weight infant births per year, and is a member of the NICHD Neonatal Research Network (Dr. Ambalavanan is the alternate center PI), the Global Network, and the MFMU Network. Basic science projects focus primarily on lung development and injury. His laboratory has expertise for evaluation of structure, function, and injury in the developing lung and cardiovascular system. In the past decade, he has developed models for the evaluation of lung development, function, and injury in newborn mice. His laboratory has established the critical role of transforming growth factor (TGF)-beta and matrix metalloproteinase (MMP)-2 in lung development, and in the inhibition of lung development and abnormal lung vascular development that occurs with hypoxic exposure. Additional projects in his laboratory focus on mechanisms underlying nanoparticle-induced lung injury, ventilator-induced lung injury, retinoid regulation of hyperoxic lung injury, and lipofibroblast to myofibroblast transformation in the developing lung. He has over 150 publications in reputable journals, including New England Journal of Medicine, JAMA, and Nature Medicine. He has served on NIH study sections including T32 training grants, and reviewed for the American Heart Association, and the American Association for the Advancement of Science. He serves on numerous editorial boards including Pediatric Research and AJP-Lung Molecular and Cellular Physiology and is a member of the UAB Center for Free Radical Biology, Center for Cardiovascular Biology, Center for Nanoscale Materials and Biointegration, and UAB Comprehensive Cancer Center. He serves as a reviewer for >30 journals. Dr. Ambalavanan has significant expertise with mentoring, having mentored a predoctoral minority candidate who completed her PhD in three years, eight postdoctoral fellows (five on faculty at present), and is currently mentoring three junior faculty. Dr. Ambalavanan is also a member of training faculty on other T32 programs at UAB, including Pulmonary and Critical Care Medicine, Hypertension and Vascular Biology, and Statistical Genetics. Dr. Ambalavanan has a strong commitment to training of the next generation of scientists and teaches notably in HMG 704 course that is part of the TMS curriculum. He was the former President of the Southern Society for Pediatric Research, and led efforts to increase membership among postdoctoral trainees and is a member of the Mentoring Committee, Strategic Planning Committee, Society for Pediatric Research, and the APS/SPR Student Research Program Steering Committee. Additionally, he is a member of the UAB MSTP Program (PhD Mentor) and of the Graduate Biomedical Sciences (GBS) faculty.

The responsibilities of the co-director are to monitor and ensure compliance with the requirements of the training including the responsible conduct of research, and oversee the clinical internship course. Finally, both Dr Patel and Ambalavanan have past and ongoing research collaborations indicated by two co-authored publications (in Nature Medicine and PLoS One) underscoring a strong working partnership.

3.1b. Administrative Structure and Responsibilities:

The administrative structure of the TMS program includes the Director, Associate Director, Executive Steering Committee, External Advisory Committee, Trainee Selection and Curriculum Committee, Clinical Internship committee and Program coordinator. The flow chart in **Figure 2** indicates their interactions with responsibilities delineated in the following sections. Faculty were selected for these committees based on their expertise in translational research, graduate student training, ability to represent the interests of both junior and senior faculty and to provide representation from the participating departments and centers.

Executive Steering Committee (ESC): The TMS Executive steering committee consists of the TMS program director (Dr. Patel) and five senior level UAB faculty members (Drs. Agarwal, Engler, Kimberly, Chaplin, Rich) from different departments/divisions at UAB and Dr Suto from the Southern Research Institute (see attached letters). These members were selected for the ESC due to their broad range of expertise, previous experience

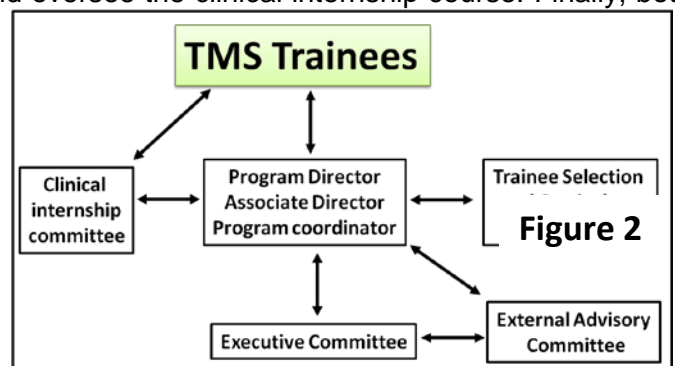


Figure 2

with training programs (including directors e.g. Dr Kimberly is Director of the UAB Center for Clinical and Translational Sciences), their student training records and commitment to graduate education. All members also hold, or have held, key administrative positions (including Department chairs, Division Chiefs, Associate Deans). In addition, three of the ESC members (Agarwal, Chaplin, Kimberly) bring clinical medicine expertise. The ESC committee will review the TMS program and make recommendations to the program director. The responsibilities of the ESC will be to (1) determine and approve program policies; (2) evaluate and approve TMS program faculty and their removal and reappointment to training status; (3) resolve conflicts that may arise in trainee selection and preceptor appointments; (4) ensure objectives of the TMS Program are met; (5) provide advice to the program director concerning utilization of funds for training related expenses; and (6) make or approve recommendation about new training initiatives, (7) interface with, and facilitate implementation of any recommendations from the External advisory committee

External Advisory Committee (EAC): The instructions for this application prohibit reporting membership of the EAC. The EAC will be asked to provide written evaluations of the program to the director and Executive Committee. A diverse panel comprising of three, nationally recognized leaders in translational research, ideally with experience in T32 training programs, from outside of UAB will be secured. Panel member recommendations will be solicited by the Executive committee. Recommendations will be reviewed and final selections (for invitation) will be made jointly by the Executive Committee in collaboration with the NIH. Recruitment of EAC will begin shortly after notice of award, and members will be secured within the first three months of support. This panel will be asked to critically evaluate the effectiveness of this program relative to other comparable programs. Specific programmatic guidance and review with respect to trainee selection and progress, effectiveness of the didactic curriculum and enrichment activities, and attainment of overall program goals will be requested on an annual basis every May to allow for implementation of suggested changes in trainee selection process or the curriculum for the following academic year (August).

Trainee Selection and Curriculum Committee (TSCC): The TSCC consists of 5 TMS preceptors (Drs. Robin Lorenz, Susan Bellis, Steve Rowe, Stuart Frank, Jennifer Pollock, see attached letters) and the program directors (Patel and Ambalavanan). The committee will meet in person bi-annually in April to review the curriculum and August to assess applications and evaluate existing trainees. Additional meetings will be scheduled if necessary. The primary responsibilities of the TSCC are to select the trainees to be appointed to the training grant, and annually review their progress and to assess the curriculum. This committee will make recommendations to the program director regarding termination or continued support of a trainee based on academic and research productivity. They also make recommendations regarding faculty training status prior to going to the EAC. With respect to the curriculum, the committee's responsibility is to ensure that the course work for TMS students is sufficient to prepare them for successful careers in translational research. Any recommendations for changes will be made to the TMS director and implemented upon approval by the Executive Committee. Faculty members on this committee were selected due to their active involvement in our current Med into Grad Translational training program as well as to UAB graduate education and training programs in general. These faculty have also served on NIH T32 study sections, or served as graduate program directors. Members of this committee are appointed to staggered terms to ensure trainee selection is not biased by a few faculty. Alternate faculty with similar expertise will be chosen in the event of conflict of interest specifically where a trainee is in, or engaged in close collaborations with the faculty's lab. Dr Patel has overseen enrollment of students into the Med into Grad program and Pathobiology and Molecular theme for 4 years as well as served on trainee selection committees for other T32's at UAB.

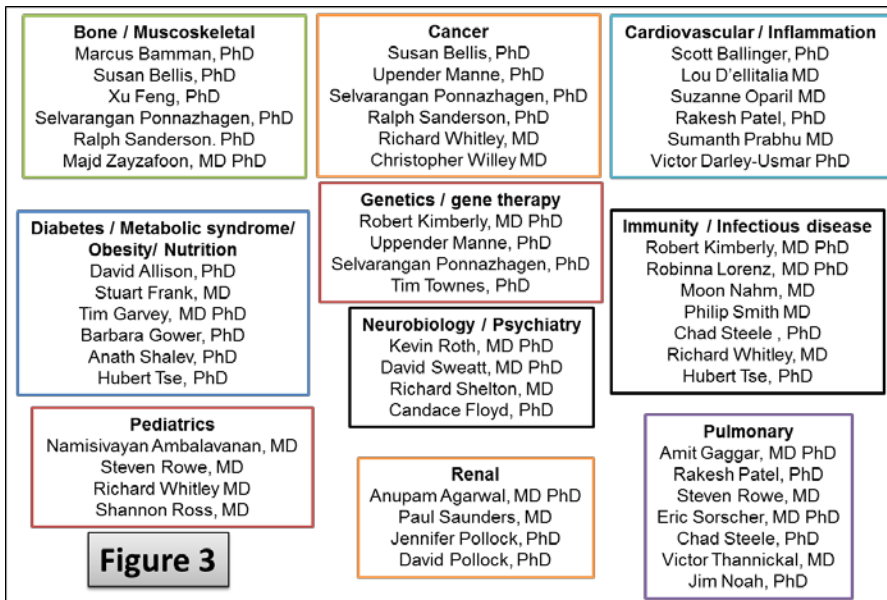
TMS Program Coordinator and Business Office: Mr Scott Austin will be the TMS Program Coordinator and brings experience based on his similar role with the Med into Grad program. He provides administrative assistance to the Program Director and TG Executive Committee, and is responsible for completing appointment papers and assisting trainees when they first enter the program and coordinating didactic aspects of the program. Mr Austin will also provide fiscal management in coordination with Ms. Lynn Roden (Department of Pathology) and will oversee the major financial and personnel-related matters (e.g., payroll; benefits; etc.) for the trainees. 25% effort for Mr Austin is requested with Ms Roden being fully supported by the Dept. of Pathology.

3.2. Program Faculty: The 42 proposed faculty (34 Professor, 6 Associate Professor, 1 Assistant Professor and 1 manager (industry, associate professor equivalent)) provide an unique array of expertise (45% PhD, 45% MD, 10% MD PhD) whose collective research addresses fundamental scientific problems with a strong

emphasis on translation and human disease. Current research that has a strong translational element was a primary consideration in selecting the program faculty as outlined in faculty research interests below.

3.2a. Program faculty qualifications and training records: As indicated more the half of the faculty hold MD degrees consistent with our goal of providing a translational training environment. Moreover, the faculty collectively provides a wealth of training and administration experience, having mentored 155 mentees, with 61 current trainees (Table 5A). Of the 154 graduates, 94% did so with a PhD or MD/PhD, 5.8% with a MS and 0.6% left without graduating. Of the graduates, 71% are currently in research (academia or industry), 18% in medicine, 4% science teaching, 3% science related law or publishing and 4% other or unknown. These objective assessments reflect the excellence of our trainees and the quality of the training environment and faculty at UAB. In addition, 14 faculty previously have, or are currently serving as graduate program or training grant program directors, and 16 faculty previously have or are currently serving as Center Directors, Division directors or Department Chairs. Finally, the TMS faculty and their trainee publish extensively in top-tiered journals; Table 6A shows that on average, each graduated trainee published an average of 4.2 papers during their thesis work. Analyses of the number of first author papers per trainee indicates that 54.7% of all publications were as first author (median value = 50%); only 5.8% of all graduated trainees did so without a first author paper (Table 6A); these metrics were not significantly comparing TGE versus non TGE trainees (not shown). TMS faculty's research is supported by NIH, VA, industry or other clinical societies (e.g. American Heart Association) funding; Table 4 shows the TMS mentors have >\$39million for research (including RO-, P- awards and clinical trial research support (mean funding per PI = \$965,999; median = \$570,765 per PI, data calculated only from grants where faculty is PI or multi-PI, and excluding all grants in no-cost extensions) with and ~\$15.9 million in pending grants. Only one proposed mentor is currently without funds; Prof. Bamman has been continuously funded for the preceding 10y, and has two proposals pending review. Prof. Bamman recently established The Center for Exercise Medicine at UAB, in which novel programs to evaluate exercise-based therapy for age-related diseases are being developed. Exercise medicine is an emerging area within translation research programs and Dr Bamman is nationally recognized as a leader in this area. We feel inclusion of his expertise as a preceptor strengthens the TMS program and anticipate that Dr Bamman will receive new funding during the submission and review of this T32.

3.2b. Program Faculty Selection: Our goal is to provide trainees with a breadth of experience in translational research that span multiple disciplines and diseases. **Figure 3** shows faculty grouped into disease areas of expertise which also represent strengths of the UAB research environment. Specific research project details for each faculty are provided in **Table 2** and **Appendix 3**. We acknowledge that some faculty (particularly physician scientists) have limited mentoring experience at all ranks (Assistant, Associate and Full Professor), but have selected these investigators (e.g. Dr Gaggar, Rowe, Ross, Sanders, and Ambalavanan) since they have an interest in pre-doctoral training (indicated in part by their willingness to be preceptors) and most importantly because they have well funded research programs that we feel would provide excellent training environments for students interested in translational research. This also meets one of our goals to increase opportunities for pre-doctoral students to engage with and learn from clinical faculty. *Importantly, many of these faculty do have significant and successful mentoring track records for medical residents and fellows. In instances where limited mentoring experience is identified by TSCC and TMS program directors, a Mentoring Program plan will be implemented.* Specifically, the TMS program director will meet with the mentor and student together with the trainee's graduate program director and discuss the requirements of the TMS program and expectations of the mentor and mentee; the UAB



graduate student handbook will be used a reference guide. The TMS program director will also follow-up with the mentor and mentee every two months and discuss progress and address any concerns, questions and unforeseen issues that may arise. In the case the mentor is junior in rank (Assistant professor), a more senior mentor will be assigned to trainee and provide assistance to the primary mentor as he / she begins to adopt their own style of mentoring. The senior mentor will be chosen from the program faculty and from a similar scientific area. All mentors (independent of experience) will also be required to participate in the newly developed UAB mentoring academy (see **Appendix 4**) which is designed to improve mentoring practices across the UAB campus. Finally, we note that the TMS training program is open to new faculty and this is encouraged at the time the applications are invited for available slots in the program. Applicant faculty will be evaluated by the TSCC and final acceptance will require approval by the executive committee.

3.2c Collaborative Interactions: In collaboration with our CTSA, we have performed a network analysis study to assess the research collaborations among preceptors. The survey administered to faculty collected investigators' grants, publications, abstracts/presentations and informal scientific interactions for the past 5 years. Researchers UAB center affiliations was also captured and analyzed for multidisciplinary connections and cross pollination. The link between researchers and their shared number of interactions are indicated by the number of ties between the researcher nodes. The data were analyzed using UCINET 6 Software, and represented graphically using NetDraw 2.106.

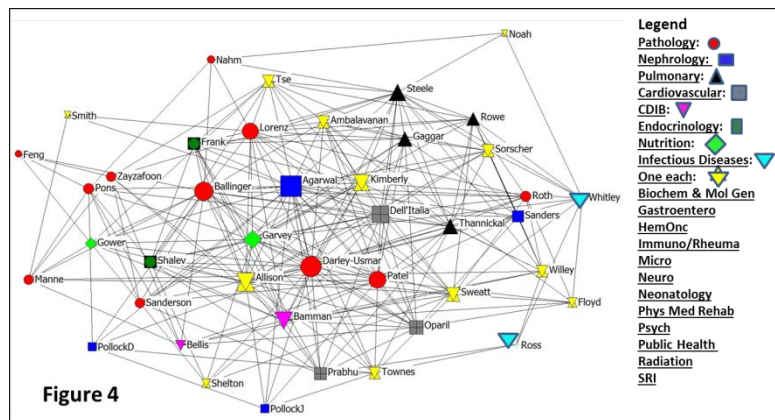
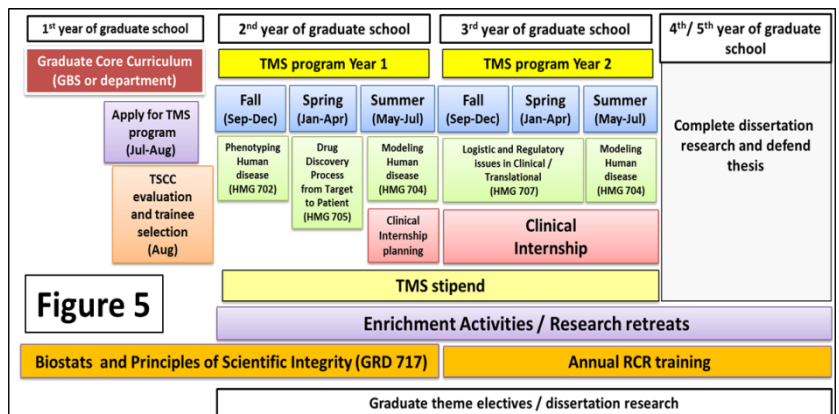


Figure 4 shows the combined interactions from formal (grants, publications) and informal (project discussion) interactions (**Appendix 14** breaks down Figure 4 to individual interaction components). Each colored node represents one investigator; with the size of the node reflecting the “degree” or number of collaborations that person has with others. In addition, the position of the nodes in the network graph is statistically derived and is relevant, so that when two nodes are closer together, they share relationships with many of the same investigators under similar

research themes. This method of positioning results in the clustering of the nodes indicating that despite having diverse scientific interests, close collaboration networks exist with many different paths through the network. This type of network structure is very positive for supporting research collaborations and provides a strong platform for trainees. These data are consistent with an established tradition of collaboration at UAB among its faculty across multiple schools, departments, and divisions. We anticipate that this program will foster this further under the common commitment of translational training for pre-doctoral students exemplified by the Modeling Human Disease (HMG704) course (described below).

3.3. Program overview

Overview: In this section the typical training program for the 6 pre-doctoral trainees per year requested in this proposal will be described together with the foundation courses and more specialized didactic elements that contribute to the TMS training grant. The Graduate Biomedical Sciences (GBS) program encompassing 8 interdisciplinary thematic programs is the primary anticipated source of students applying for this TMS Training Grant. However, based on applications to our Med into Grad program we also anticipate applications from students in the School of Public Health (Biostatistics) and School of Engineering (Biomedical Engineering). We note that applications will be considered from any UAB pre-doctoral (PhD) graduate student however with the primary criteria being that training in translational research will benefit the trainee with his/her research and career goals. Since our goal is to provide instruction so that students are better able to integrate translational research into their research, our first criteria will be for students to have successfully completed Year 1 in their



respective program and second, that students have been accepted into a laboratory with a primary project area related to human disease defined. Students enter the TMS program early in their second year and after evaluation by the TSCC, and where it is clear they have made a commitment to a research project with a translational element. A typical timetable is shown in **Figure 5**. An overview of each program that is anticipated to provide students who will apply to the TMS is provided next, followed by description of the TMS-specific training elements.

3.3a Graduate Biomedical Sciences PreDoctoral Training Program

The Graduate Biomedical Sciences (GBS) program was established in 2010 at UAB, and represents the evolution of a unique predoctoral training program that spans 8 thematic areas of research (**Figure 1**). The GBS Program is the common portal for graduate studies in the Biomedical sciences, and is composed of over 400 graduate students, across 8 interdisciplinary themes (Biochemistry & Structural Biology (8 TMS faculty), Cancer Biology (13 TMS faculty), Cell – Molecular and Developmental Biology (15 TMS faculty), Genetics and Genomic Sciences (7 TMS faculty), Immunology (10 TMS faculty), Microbiology (7 TMS faculty), Neuroscience (5 TMS faculty), Pathobiology & Molecular Medicine (25 TMS faculty)) that integrate 350 total faculty in 33 departments and 20 research centers in the School of Medicine, partner Schools throughout the university, and Southern Research Institute and Hudson Alpha which are affiliated drug discovery and biotechnology institutes. TMS training grant faculty are affiliated with multiple themes as indicated above. The GBS is directed by the GBS Steering & Oversight Committee (GBS SOC), which is composed of 18 faculty members representative of 7 departments (Pathology, Microbiology, Physiology & Biophysics, Cell Biology, Pharmacology/Toxicology, Medicine, Vision Sciences, and Neurobiology), the Medical Scientist Training Program (MSTP), and the Graduate School.

GBS Core curriculum. All GBS students are required to take 3 common core courses (GBS 707, 708, and 709) during the fall term of their first year which emphasize the fundamentals of biochemistry, metabolism, genetics, molecular biology and cell biology and assure that each student has a graduate level foundation in these core subjects. Thematic specific courses commence thereafter with students having an open curriculum allowing them to choose from courses offered by any of the eight GBS themes allowing them to customize their didactic training with their research interests. Choices are made after discussion with theme directors / co-directors and mentors. During the spring term GBS students integrate these concepts with translational and basic research coursework that complements their chosen research theme. **Appendix 5** provides details on course content for GBS core courses (Aug – Nov) and theme specific courses (Nov – Apr). In addition, the GBS Program requires successful completion of Biostatistics (BY 755 – Biometry) and Scientific Ethics (GRD 717 – Principles of Scientific Integrity (RCR training)) coursework during the second year.

*Biometry/Biostatistics (GBS 755 see **Appendix 6** for detailed course content):* All students in GBS are required to complete a course in applied biostatistics. This course provides instruction of statistics pertinent for experimental design and analytical tools typically used in biomedical research. The course introduces trainees to appropriate statistical techniques for data analysis and presentation and with the necessary computer skills required to store, manipulate, plot and analyze data using popular software packages. The course utilizes problem sets for practical experience in biostatistical analysis.

Principles of Scientific Integrity (Responsible Conduct in Research Training): The RCR course (GRD717) syllabus and full description are included in **Appendix 7** and section 5 below. **All students in the GBS program are required to complete the RCR course normally in their first or second year and a refresher course within four years. All TMS trainees will be required to have completed the RCR course within their first year in the program (second year in graduate school).**

3.3b Nutrition Sciences: Candidates will complete 33 semester hours in a core curriculum covering biochemistry, physiology, clinical and molecular biology aspects of nutrition, and statistics and research design and complete a minimum of 24 additional semester hours of nutrition sciences courses and courses supporting the study of nutrition sciences. Detailed course descriptions are provided in **Appendix 8**. 2 TMS training grant faculty are affiliated with this program.

3.3c Biostatistics: This program provides a balance between theory and application, the perspective being the role of statistics and modeling in scientific research. The objective is to produce research-oriented

scientists who can advance statistical and modeling theory and can interact effectively with scientists in other disciplines to advance knowledge in those fields. For admission to the program, a student's undergraduate curriculum must include a 3-semester sequence of calculus or equivalent, linear matrix algebra, and proficiency in computing. It is preferred that students have additional advanced mathematics courses, e.g., differential equations, advanced calculus including special functions, and complex analysis. Advanced calculus and a prior MS in statistics or biostatistics are required for admission to the PhD program. (see **Appendix 9**). 1 TMS training grant faculty is affiliated with this program.

3.3d Biomedical Engineering The Ph.D. degree prepares students for careers in industry and academics. Students entering the Ph.D. program with a B.S. are required to complete at least 54 semester hours of graduate work, including 36 semester hours of graduate course work, 6 hours of BME seminars (BME 701), and a minimum of 12 hours of Dissertation Research (BME 799) earned over at least two semesters. All students are required to take BME 770 Quantitative Physiology, BME 517 Engineering Analysis and BST 621 Statistical Methods I. The remaining course work should be a combination of life sciences, biomedical engineering or elective courses that provide sufficient breadth and depth to gain the necessary graduate-level, interdisciplinary knowledge to complete thesis research. Up to 3 credit hours of bioengineering elective course work can be taken as directed independent study if approved by the Graduate Program Committee. Detailed course descriptions are provided in **Appendix 10**. 4 TMS training grant faculty are affiliated with this program.

3.4 TMS Program Specific elements: On successful completion of the first year curriculum and laboratory rotations, the students select their thesis advisor and a research project. At this point that they become eligible for support through this training grant (**Figure 5**). Applications will be solicited between June and July at the end of the prospective trainees first year. The TMS trainee selection and curriculum review committee will review applications in mid-August and selected trainees will begin TMS specific elements in September at the beginning of their second year in graduate school. During their second year, TMS students will take courses required by their theme or departmental graduate program **and** TMS-specific courses and enrichment activities which are designed to add formal training in translational research that complement their theme / departmental based training. At first glance, this would appear to overburden students with classes which may have a negative effect of hindering progress towards their lab-based research project. However, the TMS courses may count towards theme requirements consistent with customized curriculum model and the courses are designed to not be time consuming nor onerous, and are unique courses that are didactic and interactive that will complement trainees overall training. Moreover, during our 7 years of experience to date with our Med into Grad program, in which these courses were required in addition to all theme or departmental courses, we have not received any feedback from students (>50) indicating that these required courses were burdensome. On the contrary, these courses (described next) are highly successful indicated by the fact that non-Med into Grad students requested to take these courses. Moreover, we note that time to degree is not hindered relative to non Med into Grad students (5.2y vs 5.9y respectively) despite the additional courses required. Finally, it is anticipated that TMS trainees will assemble their dissertation committee during their first year in the TMS program; a requirement will be to have at least 1 physician or physician-scientist on their dissertation committee. In addition, Dr Patel or Ambalavanan will serve as a non-voting member of the dissertation committee, unless the trainees research project would directly benefit from either of the PI's research or clinical expertise, in which case, a voting member position would be recommended. In the event that both Dr Patel and Ambalavanan are unable to participate in every committee meeting, a member of the Trainee selection and curriculum committee will serve. These stipulations will have to be agreed to by all prospective TMS students and mentors prior to starting TMS curriculum.

TMS Didactic Program. Four courses are proposed for TMS to fulfill three general objectives. 1) Courses are intended to reduce the intellectual distance between bench and bedside through instruction of medically-relevant, patient-oriented information by top physician-scientists, i.e., teach trainees clinical medical science using clinical case-based approaches. 2) Courses provide trainees with knowledge of the modern drug discovery process. 3) Didactic experiences provide conduits for matching fellows with experiences and mentors for research projects in contemporary disease-based research. The following sections describe the rationale and specific objectives for each course. Special attention was paid to the sequence of the courses to ensure they complement each other and provide necessary training and information for the clinical internship (year 3) to be useful. We recognize that TMS students will have a diverse didactic training background depending on their primary theme / departmental affiliation. With this in mind admitted TMS fellows will begin during the fall semester with the Phenotyping Human Disease course (HMG702) which will provide the

foundation for subsequent courses. Trainees begin dissertation research while still participating in TMS and CCTS journal clubs, retreats, courses and enrichment activities as determined by their mentor and doctoral advisory committees. Successful graduation will be determined by the graduate program requirements.

3.4a Phenotyping Human Disease (HMG 702, Course Director: Robin Lorenz, MD, PhD, TMS Preceptor and TSC committee member). *Rationale and objectives:* Biomedical scientists of the 21st century must have the breadth of understanding to participate in investigations which span a wide range of disciplines. Competencies in structural and functional biology are prerequisite to understanding the complex interactions of genomics and proteomics. The goals are to introduce fellows to the basics of structural and functional biology (histology and classical pathology) in the context of clinicopathologic case studies. Emphasis is given to animal models of human disease to provide a focal point for understanding basic investigative mechanisms and procedures. This course has been organized to provide the conceptual framework behind many experimental approaches to discovering and quantifying disease phenotypes, as well as hands-on opportunities to see how these approaches are performed in real experimental situations (human autopsy and examples of animal models). This course occurs during the first year in the TMS program so that fellows can utilize these important methodologies for their dissertation. *Course Description:* This course uses a combination of didactic lectures and hands-on laboratories to teach multiple methods for analyzing disease phenotypes in humans and in animal models. It is organized around 4-5 disease themes, which each demonstrate specific approaches. Course instructors are UAB investigators and Core Directors with expertise in the disease areas or techniques being taught. Disease themes / approaches illustrated have included: diabetes/obesity/metabolic syndrome, laboratory and imaging analysis; neurofibromatosis, neurological diseases genetic analysis and genetically engineered animals; diseases of the premature infant, models of ischemia reperfusion injury, behavioral and memory analysis in animal models. Specific themes include: cardiovascular disease - MRI and ultrasound to analyze cardiovascular structure and function in man and animal models; breast cancer – optical imaging to analyze metastatic behavior and gene therapy approaches; neurodegenerative diseases – behavioral and neurological examinations; and inflammatory bowel disease – histological and molecular analysis. As part of this class, TMS fellows are exposed to a wide variety of clinical settings. They start by attending the Anatomic Pathology Diagnostic Conference, which discusses and demonstrates the final diagnosis of several recently completed autopsies and serves to expand the horizons and vocabulary of the TMS students. During the course, the students also shadow a neonatologist and observe a patient undergoing a glucose clamp procedure. TMS fellows can follow-up on this clinical exposure by electing to take the PAT777 "Autopsy Experience". The objective of PAT777 is to familiarize students with the science and process of autopsy by direct 'hands-on' experience, enabling them to gain appreciation of the roles of molecule-based studies as they related to human disease. Based on feedback from this course (available since 2005), the autopsy experience provides students with greater understanding of disease etiology in a broad sense, and therefore provides students with a greater comprehension of the translational aspects of molecular research. These initial clinical experiences are continued long-term in the clinical internship course (see below) and as TMS mentors develop student specific enrichment activities that distinguish TMS fellows from other students (described below). *Anticipated Outcomes:* Fellows gain knowledge and tools to conduct phenotyping studies in multiple types of diseases. This allows identification of the nature of the defect/disease and assessment of how such alterations relate to deviation of normal gene expression, cellular physiology, and structural ramifications. *Assessment:* Students have evaluated this course each year over the last 5 years and rated it outstanding. Looking forward, each specific disease module will be evaluated annually, and based on responses, disease modules will be either retained, refined or replaced in subsequent years.

3.4b Drug Discovery Process from Target to Patient (HMG 705); Course Director: Mark Suto, PhD, Southern Research Institute) Dr. Suto has over 20 years of experience in the pharmaceutical industry and brings a wealth of practical knowledge regarding the drug development process to this course. He will also serve on the ESC. *Rationale and objectives:* A recent survey of full-time employment (beyond post doc) held by UAB PhD graduates indicated that >20% were employed in pharmaceutical or biotech companies. Scientists assumed these positions with requisite technical and theoretical skills, but with little training in the workings of modern drug discovery programs. Pharmaceutical companies historically assumed the role of training new recruits in the process of drug discovery and development. However, applicants with knowledge and/or experience in drug design and testing would be better candidates for these positions. *Therefore, PhD programs should incorporate appropriate introductory training into the modern drug discovery process.* This element is key in the context of training biomedical scientists to rapidly move discoveries in the lab to new

drugs and treatments for patients. UAB is fortunate to have close geographical and academic relationships with SRI. **A unique feature of this training program is the direct involvement of SRI faculty in teaching all classes within this course.** *Course Description:* This course follows the pipeline of drug discovery from target selection to FDA approval. Lectures include: Introduction to Drug Discovery, Target Validation, Selecting the Right Target, High Throughput Screening, Hit to Lead to Candidate Optimization, Preclinical Toxicology, DMPK Bioanalytical Analysis, Clinical Trials, and Business Development & Drug Discovery. Additional lectures will cover infections, CNS and cancer drugs and targets, structure-based drug design, assay development, high content screening, and mechanisms of drug action. Fellows see first-hand the high throughput screening facility and other facilities at SRI. They also learn about biosafety level III with ongoing research on high pathogen avian flu and SARS. *Anticipated Outcomes:* Fellows will gain an understanding of the modern drug discovery process, including the steps from identification of lead targets to completion of clinical trials required for FDA approval. This course challenges fellows to think about how the molecule or pathway identified in their research could be targeted and validated and underscores the importance of the drug/device approval process, and how safety and efficacy evaluation require assessment of data from multiple scientific disciplines.

3.4c. Logistic and Regulatory Issues in Clinical & Translational Science (HMG 707) (Course Director: Rakesh Patel, Pam Alverson, Course Manager) *Rationale:* Biomedical graduate students receive excellent training in basic science but often have minimal exposure to clinical research. Yet, many find themselves conducting research that requires the ability to assess clinical research data to guide the direction and emphasis of their research. To remedy this, TMS fellows become familiar with the principles and methods of clinical research and learn how to critically evaluate medical research literature and understand how clinical questions are framed, how studies are designed, and how knowledge is transferred to the bedside. *Course Description:* Students (2-3 per group) attend two meetings of the UAB Comprehensive Cancer Center's Clinical Trials Review Committee (CTRC). The CTRC comprises 36 members representing all oncology specialists, bone marrow transplantation, surgical nurses, basic scientists, statisticians, and radiologists. The CTRC's responsibility is to scientifically review, approve or reject protocols and to establish priorities for clinical protocols conducted within the Cancer Center, including NIH- or cooperative group-funded trials. Prior to the CTRC meeting, students are paired with primary reviewers to serve as *ad hoc* reviewers for a specific protocol. Students work with the senior clinical or biostatistical reviewers and will present to the CTRC their assessment with regards to recommendation for approval, administrative review (minor concerns), resubmission (major concerns), or disapproval is made along with assignment of priority scores. Exposure to this process provides an introduction to study design, IRB issues, and data analysis. *Anticipated Outcomes:* Fellows are able to critically evaluate medical literature and understand how clinical questions are framed, how studies are designed, and how knowledge is transferred back to the bedside. *Assessment:* We appreciate that not every student will be engaged in cancer research. However, our experience with this course based on student feedback is that independent of the student's research interest, the opportunity to immerse themselves in the process of reviewing grants provides a unique perspective to a key regulatory aspect of clinical trials. In the event a trainee feels that this was not a valuable experience, trainees will be encouraged to participate in CCTS courses designed to interact, as observers, with our institutional IRB. We note that the course we propose here involves trainees reviewing and providing recommendations, (under faculty supervision); in other words they are intimately involved in the process as opposed to 'simply' observing the process.

3.4d Modeling Human Disease (HMG704; Co-Directors: Amit Gaggar, MD, PhD and Shawn Galin, PhD) *Rationale and objectives:* This didactic experience serves two purposes: 1) To provide trainees with a stimulating introduction into the study of disease-based research, facilitated by top disease-oriented scientists and clinicians. *Course description:* This disease- and case-based, clinical, pathobiology conference-style experience was adapted from an existing medical student elective that is routinely evaluated as one of the best courses in the UAB Medical School. This 6 wk course is also extremely popular with the HMG fellows. During the first hour, a UAB physician-scientist presents a patient who interacts with the clinician and trainees, including relevant physical exam data, laboratory data and clinical management and Q&A session. The second hour is led by a prominent researcher in the respective disease area who highlights current research, molecular basis of the disease, and mechanism for diagnosis and treatment. TMS trainees will take an active role in the course curriculum and will be responsible for choosing the topics and speakers under the course director guidance. TMS fellows identify the most appropriate academic physicians and basic researchers for presentations, thereby familiarizing them with faculty and teaching them to assess clinical and research quality. This process also takes advantage of UAB's major faculty strengths. Fellows are responsible for

introducing speakers, which gives them further insight into the training, accomplishments, and quality of the selected faculty. This course will be offered every year and open to all TMS current and previous trainees. As students progress through the TMS program, their responsibilities shift. During Yr2 (first year in the TMS program) fellows will select topics and faculty to participate. An initial meeting in the spring will be scheduled between students and course directors, who will facilitate trainees in identifying disease topics and respective clinical and basic science faculty. In Yr 3, trainees will take on a more moderator role and be required to engage with presenters and participate in presenting and discussing patients. These hands-on responsibilities serve several important purposes. First, they encourage interactions between fellows, faculty, and patients. Second, they demand in-depth knowledge of the disease and its relationship to basic science. Third, they may stimulate and guide fellows to an area of particular interest or identify possible connections between the students' interests and approaches undertaken in different lines of research. Last, early in their training, fellows are exposed to the actual workings of an academic health center. In addition to their understanding and interactions with faculty, this course serves as a model to incorporate classroom interactions with TMS fellows. Because first year trainees will be selecting topics, we anticipate that each year different disease areas will be covered. Course directors will also ensure that diseases are not repeated over any two consecutive years. *Anticipated Outcomes:* The primary goal is to introduce TMS fellows to the study of human diseases and patient interactions and in particular, to thinking in terms of what may be learned about molecular mechanisms from the cross-fertilization of basic and clinical research. In other words, what have been considered two separate disciplines are not necessarily different when approached at the molecular level. This strategy breaks down barriers between the knowledge gained in basic animal studies and the application of that knowledge to the development of new disease treatments. (**Appendix 11** shows topics covered in this course since 2010)

3.4e Clinical Internship: Course Director: Dr Ambalavanan MD. A new individualized clinical experience rotation will be developed for TMS trainees. Students will be linked with a clinician working in their research area of interest, who will guide their internship with the assistance of the program faculty. This clinical internship will occur in the inpatient and/or the outpatient setting, and include exposure to clinical imaging and laboratory as well as pathology services. In May-June at the end of the trainee's first year in the TMS program, the trainee, mentor and course director will meet to discuss and broadly define the nature of the internship that would best benefit the trainee in relation to his / her research interests. A clinical mentor with whom the internship will be performed will then be identified and a subsequent meeting with all parties scheduled in July-August to finalize the specific details of the internship. The internship will occur at any time between Aug-May in the trainees 3rd year (second year in the TMS program) and result in 'meaningful' experiences. We have opted to not put a specific minimum contact hour requirement on this course, since our goal is to customize this experience for the trainee. The, trainee, mentor, course director and clinical internship mentor will collectively define what would be considered to be a meaningful experience for the trainee. We note, that during these discussions, ensuring that the trainee does not spend too much time in the internship at the detriment of moving forward with his/her research progress will also be a key consideration. If, between the mentor and course director, an appropriate clinical faculty cannot be identified, the program director and members of the TMS TSCC will be consulted for assistance. We do not anticipate any problems in finding a clinical mentor for the trainee internship and note that Drs Patel and Ambalavanan, together with the preceptors listed on this proposal provide a broad coverage of expertise in diverse diseases that involve close collaborations with UAB physicians and physician scientists. To illustrate the potential contents of a clinical internship we provide the following examples for potential internship content for students interested in for example mechanisms of cardiac failure or atherosclerosis:(a) rotate through the Hypertension outpatient clinic and the Cardiology outpatient clinic to observe patients with hypertension or cardiac failure and see echocardiograms being performed, (b) shadow the cardiologist during inpatient cardiology rounds, (c) observe coronary angioplasties in the cardiac catheterization laboratory and cardiac bypass surgery in the cardiovascular surgery operating rooms, (d) attend clinico-pathologic conferences and observe cardiovascular pathology during rotations through surgical and anatomic pathology, and (e) observe routine radiographs, vascular ultrasound, cardiac MRI, and nuclear imaging during rotations through Radiology. Similarly, a student who is working on the mechanisms of acute lung injury in the laboratory will be matched to a clinician in Pulmonary and Critical Care, who will develop a rotation involving (a) rotation through the Pulmonary outpatient clinic and Cystic Fibrosis clinic to observe patients with chronic obstructive pulmonary disease (COPD), severe asthma, cystic fibrosis, idiopathic pulmonary fibrosis (IPF), survivors of acute respiratory distress syndrome (ARDS) etc, and see pulmonary function testing (PFTs) being done, (b) attend rounds in the medical intensive care unit and pediatric intensive care unit to observe patients with ARDS and other

respiratory conditions, (c) observe bronchoscopies, thoracentesis, performance of bronchoalveolar lavage and lung biopsies done by pulmonologist, (d) observe chest CT and MRI and 3-D reconstruction, V/Q scanning, and other radiologic procedures during rotation through Radiology, and (e) attend clinico-pathologic conferences and observe respiratory pathology (histology and gross pathology) during rotations through surgical and anatomic pathology. The supervising clinician will discuss with the participating clinicians at each of these sites of these rotations and enable involvement if he/she will not be directly available (e.g. a Pulmonologist supervising the Radiology or Pathology rotations). All students in the program will also rotate through the hospital laboratory to observe sample labeling, processing, analysis, and storage to understand GLP (good laboratory practices) in a CLIA (Clinical Laboratory Improvement Amendments) approved setting. All trainees will be required to attend necessary courses on HIPAA, patient safety (e.g. hand washing guidelines) and will receive white coats and badges with observer status enabling access to the hospital and other rotation sites. At the conclusion of their clinical internship in Jun-July, students will write a synopsis of their experience, and provide an oral presentation to other program students and faculty detailing their experiences and how this has influenced their individual research projects. Completion of the written and oral presentation will be required to receive a passing grade. Feedback on each of the rotations will be collected from both student and rotation site clinicians to enable ongoing performance improvement.

3.4f TMS Certificate Program and Eminent Speaker Series. All TMS trainees will be enrolled in the Certificate Program in Translational and Molecular Sciences (**Appendix 12**). This Certificate was recently developed at UAB as a direct result of the increasing interest in translational research training for pre-doctoral fellows. A certificate is awarded if students complete and receive 12 or more credits from courses considered to provide translational training and is open to all UAB pre-doctoral trainees. The courses that comprise the Certificate program offer elective courses that TMS trainees can select to further customize their translational research training. Moreover, TMS trainees will take the lead in organizing speakers for the newly developed Eminent Speaker Series, the goal of which is to invite leading translational research investigators from academia, government, and industry to UAB to present their research and interact with our trainees (a \$1000 honorarium will be provided). TMS trainees will be responsible for selecting and inviting prospective speakers, with the TMS program providing administrative and intellectual assistance as needed. To date 3 speakers have presented Dr Michael Snyder, Stanford University (April 2013); Dr Mark Gladwin, University of Pittsburgh (Oct 2013) and Dr Kastner, NIH (Mar 2014) and Dr Krystal (NIH) scheduled Oct 2014. This speaker series will allow TMS trainees a unique opportunity to interact with leading translational scientists. The Eminent Speaker Series is also supported by strategic planning funds from the SOM. Though presentations are geared toward the TMS fellows, they are open to the entire research community.

3.4g TMS Enrichment Programs. The third component of the TMS is designed to develop esprit d'corps amongst fellows, catalyze interactions between fellows and faculty and fill in curriculum gaps in the areas of leadership and management skills; scientific writing, critical review of data, presentation skills; and interactions with industry and regulatory agencies. These activities will occur periodically throughout the year (~every 2 months) and in part, in conjunction with the CCTS and *will also provide trainees with exposure to different career options.*

Retreat: A research day / retreat will be held on the UAB campus and planned / organized by TMS trainees with administrative support from the TMS program. All TMS students, including those who have completed the 2 year program will be asked to present either a poster. Senior TMS trainees who have completed the 2-year program and are in their 4th year of their PhD will be asked to give oral presentations (15-20min). In addition, TMS trainees will select a keynote translational scientist from UAB for an oral presentation. The keynote speaker will be asked to present their research and share their experiences that shaped their careers as translational researchers. This forum will provide a venue for TMS students to share their research with each other and learn from pre-eminent UAB translational scientists. We have employed this format over the last two years for our Med into Grad program and have had Drs Kimberly and Whitley as key note speakers. Both these faculty are preceptors on the current proposal. All TMS trainees will be required to participate in annual retreat.

CCTS Interactions: Scientific Writing Series: provides practical assistance in the development of scientific manuscripts, career development and research grants and scientific presentations. The goal of these activities is development and submission of individual NRSA fellowship applications. *Career Guidance Program:* TMS

fellows also attend a semi-annual program facilitated by senior faculty. This series of lectures and interactive sessions utilizes the HHMI/Burroughs-Wellcome *Making the Right Moves* as a manual for instruction and addresses challenges related to career development and scientific research management. Through mentoring relationships, faculty provide tailored career development guidance that assists fellows in achieving their post-doctoral career goals. *The Art and Process of Collaboration*: The trend in 21st Century science is toward team, rather than individual, research. Yet, the majority of training focuses on an individual's technical training, rather than how to form and maintain synergistic collaborations. Topics to be discussed include pre-collaboration agreements regarding expectations, milestones and publications (including coauthorship); what to do when things seem to be falling apart; communication; and data exchange. Incorporated into this workshop will be elements of appropriate notebook maintenance, focusing on what will be required for intellectual property claims. Faculty from SRI and the UAB School of Business will provide insights related to organizational dynamics and the psychodynamics of teams. Together, the research program, didactic components and enrichment activities of the TMS will expose the next generation of biomedical scientists to the culture and language of clinical investigation in order to prepare them for prominent roles on translational research teams. TMS trainees will be required to participate in these workshops at least once.

Other enrichment experiences. Meet an editor: UAB is fortunate to have faculty in prominent positions at various journals including as Editor in chief and Associate Editor (for example Dr Roth, preceptor on this proposal, is Editor in Chief for the American Journal of Pathology, and Dr Matalon is Editor in Chief for the American Journal of Physiology, Lung Molecular and Cellular Physiology)). Faculty in these positions will be invited to present an overview about the editorial and review process including an emphasis on how journals search for, and deal with ethical issues regarding plagiarism, data manipulation etc. This will complement formal ethical training required by TMS students.

Photoshop workshop: Trained UAB personnel who offer software training for Adobe Photoshop and other image processing software will be invited to provide an interactive, hands-on training session in use of these software with specific emphasis on how simple and unintentional image manipulation and editing can occur. We deem this important since the majority of image manipulations are accidental due to a lack of understanding of image processing software. This will complement formal ethical training programs.

Birmingham Business Alliance (BBA): Steven Ceulamans, Vice President, Innovation and Technology of the BBA will discuss the key role for translational and biomedical scientists in forging strategic partnerships with local businesses and to foster a spirit of innovation coupled with commercialization of findings made in the biomedical environment. In addition Dr Schwiebert will discuss his experiences in setting up a company and technology based venture planning. Dr Schwiebert is a former UAB faculty member and founder and CEO of *Discovery BioMed*. He has trained several pre-doctoral trainees and is qualified to provide insights into the unique challenges faced by PhD trainees in moving from academia to industry and taking the right idea from the lab to the marketplace.

Teaching training. UAB has recently opened a Center for Teaching and Learning (CTL) (<http://www.uab.edu/ctl>) who offer workshops and assistance with technology and teaching paradigms (e.g. flipped classroom approaches). We will ask CTL faculty to provide workshops for TMS trainees with a goal of introducing current teaching paradigms and techniques. We feel this will assist TMS trainees to become better educators and provide exposure to diverse skills required for today's workforce.

Big Data sets: The introduction of trainees to large data sets is now emerging as a critical component in their training. Dr Jonas Almeida, Professor and Director of the Division of Informatics, Department of Pathology, UAB to provide a summary of current and commonly used data bases as well as approaches used to use and manage these resources. Dr Almeida is currently developing a specific graduate course on informatics for translational research. Once available, this will be a required course for TMS trainees pending approval by the TSCC and Executive committee. We note that specific themes / programs also have courses focused on specific aspects pertaining to bioinformatics (**Appendix 5**).

Personnel Management in a Professional Setting TMS trainees will participate in the Myers-Briggs Type Indicator program and learn how they can effectively approach personnel management and team building. We will employ a group "WorkLife Consulting" who is outside UAB to run these courses (and have utilized them previously). We feel it is critical that trainees learn to effectively participate and manage multi-disciplinary teams at the earliest stage in their training and this course offers the first step in that direction. *Finally* TMS trainees will be encouraged to participate in formal and informal courses and workshops covering a wide range of areas such as career opportunities in academia, industry and law, effective presentation and discussion skills, grant and scientific writing, and lab management (see also section 2.2g above). These workshops and

courses are administered by the Office of Postdoctoral Education, a highly acclaimed office that has contributed greatly to UAB being ranked as one of the top Universities for Postdoctoral training <http://www.uab.edu/news/latest/item/2207-postdocs-rank-uab-first-among-public-universities> published by The Scientist Magazine.

All TMS trainees in year 2-4 will be required to participate in enrichment activities. We will encourage upper level students particularly year 4 students, to take leadership roles in organizing and proposing ideas for enrichment activities. Year 5 students are expected to be in the final stages of completed their thesis requirements; for this group presenting at the research retreat will be required, but attendance in enrichment activities optional.

3.4h Monitoring the Time to Degree: Our first and most important commitment is to provide students top quality training, which we feel can be accomplished over reasonable times. The PI has a documented track record and commitment to high quality graduate training in relatively short times. The Director and Co-director will review trainee progress every 6 months (or more frequently if mentor has limited experience), in part by attending all student dissertation committee meetings, with the TSCC evaluating the trainee annually. If the director or co-director are in conflict, two members of the TSCC will perform biannual evaluations. Since each student will have different requirements per their respective program or theme affiliation, it is our goal during this biannual review to provide constructive feedback to ensure the trainee is making satisfactory progress toward finishing the requirements for the Ph.D. degree. Typical requirements for GBS theme students qualifying exam and matriculation are detailed in the GBS handbook (http://www.uab.edu/gbs/home/images/GBS_2013-2014_Handbook_091713.pdf). TMS trainees will be required to establish their committee by the middle of their 2nd year in graduate school, with a goal to take their qualifying exam by the beginning of year 3 and no later than the end of year 3. If progress is determined to be slow, appropriate recommendations will be made to the trainee, the mentor, and director of the respective theme or program the trainee is in, with the request that this feedback be also shared with the dissertation committee. *Based on experiences with the our Med into Grad program, we anticipate that the TMS curriculum and enrichment exercises, will motivate students and provide them with skills early on in their training that will not hinder, and in fact facilitate faster matriculation times. This is reflected by an average time to degree of 5.2y for HMG students (16 graduates to date) compared to 5.9y for Joint health science students (600 graduates over the last 10y).*

3.5. Trainee Candidates and Selection: In May of each year, a call for TMS applications is announced indicating the number of open positions (requested 3) to all TMS mentors, department/division chairs and faculty in all departments / themes / centers shown in Figure 1, as well as to all graduate programs across the UAB campus. Applications are submitted to the program director from prospective students and include academic progress/grades, assessments of academic and scholarly attributes and potential from the mentor and graduate theme / program director together with a 4 page description of the planned research project that includes details of the candidate's career goals and why training in translational research is sought. Applications will be evaluated by the TSCC with criteria including the applicant's academic record, progress in the first year courses and most weight will be given to the whether there is a clear translational focus of research project. *Since our objective is to help develop the talent and skills of trainees with a clear interest in translational research, we note, that selection of trainees may not coincide with the highest academic grades.* Applicants who pass this initial round of review will be invited to present their research project to the TSCC in a chalk board talk format (5-10min) before final decisions are made by the middle of August. Admission decisions rest with the TSCC. Accepted trainees will start in the program September 1 at the beginning of their 2nd year in graduate school. Students may receive support for two years only which will commence in September at the beginning of year 2 pending receipt of documentation that the mentor and student will comply to the requirements of the TMS program. Continuation of support in the second year of the TMS program will be dependent on the student's continued progress toward their degree as determined by the bi-annual assessments (see above).

Admissions and completion records for the participating departments, divisions, and programs during the past five years are summarized in Data Table 7A. The average number of TGE applicants to our predoctoral programs between 2008 to 2013 was 713 per yr, with the number of enrolled TGE students being relatively constant (average 69 per year), comprising 82% of total enrolled students (Table 7A). Table 7A and 8A show that of the most recent class (2013), 84% of enrolled students were TGE and had average GPA = 3.6, GRE V-

67%, Q-66%. These data indicate that potential pool of trainees for this training grant are of a high caliber and are attracted from a nationwide recruitment pool. The quality of the trainee pool is further reflected by data in **Table 9A**, that shows of the current students 166 are TGE (representing 86% of all students), the average GPA = 3.6, GRE V-156, Q-156.

3.6. Program Evaluation: The primary goal of the TMS program will be to develop PhD researchers who understand disease processes and have the skills to effectively translate findings in the modern biomedical arena. We will continuously evaluate processes and outcomes toward this objective. Evaluation exercises will be used to iteratively enhance every component of the process and content of the TMS program. Successful processes will be continued, with an eye on improving efficiency. Unsuccessful and non-productive processes will be revised in accordance with the priorities of the program. *Process Evaluation.* The TMS program will be evaluated annually by the External Advisory committee in conjunction with the Executive committee. In addition the program director, co-director and TSCC will monitor the efficiency and effectiveness of recruitment tools, including program announcements, applications from under-served and under-represented minority and ethnic applicants, and the qualifications of the matriculates. All courses are evaluated by students and instructors to ensure that the material provides TMS graduates with the skill sets necessary to succeed. Finally, each component of the enrichment programs is evaluated for organization and clarity of presentations, relevance of material, and the ability of each component to increase interactions between fellows and faculty. In addition to course evaluations, trainees and mentors will also be evaluated by:

i) **Establishing consensus for progress and benchmarks between mentors and trainees:** At the beginning of training an individual development plan (IDP) will be prepared jointly by the trainee and mentor that utilizes (see **Appendix 13**): i) a values and ii) skills assessment (e.g. scientific knowledge, research, and writing abilities), and iii) an interests assessment. Based upon these, an IDP is designed to help focus both the trainee and mentor on the trainee's career goals.

ii) **Monitoring and evaluation of Research Progress:** A progress report, jointly written by the trainee and his/her primary mentor, is submitted to the Program Director every 12 months, and the progress evaluated by the TSCC. Critical benchmarks will include (1) successful completion of courses, (2) admission to candidacy for the Ph.D. degree, (3) awards for recognition of excellence in research, publications and progress in the research project. (4) Achievement of preset goals determined by the IDP. If progress is below expectations (e.g. below a B average in courses, limited progress towards completion of research or IDP goals) the Program director will meet with both the trainee and primary mentor to discuss an appropriate course of action to improve performance.

iii) **Evaluation of the Mentor and Program by Trainees:** At the time of the annual progress review mentors and program are evaluated by the trainees using a confidential survey. The comments will be reviewed by the Program Directors, Executive and External Advisory committee. We will also constantly monitor the composition of the mentoring pool to ensure that we maintain and strengthen the multi-disciplinary nature of our program faculty. An important assessment of the TMS program will relate to the esprit d'corps that develops among the students. With this in mind, the program director will ensure that he meets with all TMS trainees (year 2,3,4 and 5 students) monthly over lunch to receive positive or negative feedback on the program, and discuss any issues.

iv) **Evaluation of objectives:** To evaluate objectives outlined in 2.1e an exit survey will be administered to all TMS trainees that will capture these data. We will also follow up with TMS trainees 1 year after graduation to evaluate the impact of TMS training has been on trainees next career and future career goals/ plans. A draft evaluation form (developed in collaboration with UAB CTSA) is provided in Appendix 15. The definition of translational research and how its success is evaluated is an ongoing topic of discussion at the NIH and in the literature (for example see Trochim et al (2011) Clin Transl Sci 4(3): 153; McGartland Rubio (2010) Acad Med 85(3): 470) or <http://news.sciencemag.org/scientific-community/2014/05/how-succeed-translational-science>). Drs Patel and Ambalavanan will stay abreast of these discussions and accordingly modify TMS evaluations to capture pertinent data; any changes would be discussed with internal and external advisory committees for approval. All data collection and analysis will be performed with the CTSA.

3.7 Institutional Environment and Commitment to Training and the TMS Program: UAB has a strong commitment to growth as a training and research institution. All students accepted into the GBS program are

supported in year 1 through institutional fellowships of \$26,500 prior to selecting a thesis mentor, and \$27,500 after completing their qualifying exam. Tuition and fees, and single coverage health insurance is also included. This level of support is competitive with similar institutions across the country especially in light of the low cost of living in Birmingham. In the event a mentor runs out of funds, the mentors department is responsible for student stipend. Also UAB faculty have available both school wide and department / division specific mechanisms to apply for bridge funding to ensure projects can be continued to completion. Substantial support for this specific training program is provided for administration and accounting from PI's primary department, the Department of Pathology. Participating UAB centers support supplemental travel awards for trainees (typically \$500) to attend national meetings and the Department of Pathology also offers a Trainee Travel award (\$500) which is administered by Dr Patel. The shortfall for stipends and insurance from that budgeted by the training grant is provided by the mentors or departments.

UAB Graduate School provides significant support for graduate training that include:

- i) Organizing annual *Graduate Programs Fair* recruitment events for local and regional undergraduates. It also hosts the NIH-funded UAB PREP post baccalaureate program, and provides recruitment and ongoing mentoring programs for minority graduate students. The Graduate School provides the *ApplyYourself* application and admissions data management system for the use of all graduate programs, with tailored follow-up reminders at various stages of the application process.
- ii) The graduate school provides a rich assortment of professional and career development courses / workshops run by the [Professional Development Program](#) division of the graduate school in *Grant-writing, Writing for scientific publication, Oral presentation skills, College-level teaching, Developing a teaching portfolio, Annual Graduate Student Research Day with oral presentations and competitive awards, Training in the ethical conduct of research, Individual Development Plan (IDP) preparation instruction, using myIDP.*
- iii) The Graduate School has recently joined the [Center for Research, Teaching, and Learning \(CIRTL\)](#), an NSF-funded teaching consortium to improve teaching skills for graduate and postdoc trainees of participating institutions and which provides teaching certificates through that program. The Graduate School also partners with UAB Career Services to support a **Graduate & Postdoc Career Services** unit to provide career development workshops, one-on-one and online services.
- iv) The Graduate School houses the Office for Postdoctoral Education which sponsors a rich array of professional skills and career development training programs that are available to both graduate students and postdocs, including *Lab Management, Grant Writing, and Translational Science*. A summer-long **Job Skills course** for graduate and postdoctoral trainees includes content on Career Exploration, Job Search Strategies and Career Management, which is aligned with on-site career counseling for graduate and postdoctoral trainees by a dedicated PhD careers specialist. In addition, the Graduate School provides partial support to the *Graduate Student Association (GSA)* and other student groups, including **UAB Graduate Career Awareness and Trends (GCAT)**, a student-led organization that sponsors a seminar series and annual career day, exploring diverse non-academic career options for trainees in the sciences.
- v) A [Graduate School Incentive Program to Promote Individual Fellowship Applications](#) provides small monetary incentive awards for *submitting* applications for peer-reviewed extramural fellowships and more substantial awards for successfully *achieving* such fellowships wherein the Dean supplements the award stipend to the UAB required stipend level if needed, plus \$1,000; the program enjoys an approximately 30% success rate since its inception in Spring 2007 and has been accompanied by a greater than 5-fold increase in individual fellowships.
- vi) The Graduate School is involved in mentor training and recognition. The Dean's Award for Excellence in Mentorship recognizes UAB faculty members who have demonstrated exceptional accomplishments as mentors of pre- and/or postgraduate trainees and who have been nominated by their trainees. In addition, an annual **UAB Mentoring Academy** for new and junior faculty is organized through collaboration of the Associate Dean for Postdoctoral Education, the School of Medicine Sr. Associate Dean for Faculty Development and the Vice Provost for Student & Faculty Success. The day-long event, which typically hosts about forty faculty participants recommended by their chairs, includes sessions on *Mentoring Competencies and Models, Roles and Responsibilities of Mentoring, the Process of Mentoring, and Strategies for Mentoring Success*, followed by case-study sessions on *Building Trust, Differing Career Goals, and Cultural Understanding*. These sessions are designed around the HHMI-sponsored *Entering Mentoring Seminar* developed by Dr. Jo Handelsman, University of Wisconsin
- vii) **Graduate Biomedical Sciences:** The Graduate School, in collaboration with the SOM has made major

investments in the GBS program to support the programs used by this application which includes 5 theme program staff, business office and Associate Dean. Key areas of support are i) Organization of GBS-wide participation in national minority and other graduate recruiting events, ii) Oversight of 1st year orientation for GBS-affiliated program students, iii) financial and personnel management oversight of entering students, iv) [GBS website](#) with content for applicants, current students, graduate alumni, faculty and administrators, v) Training grant data and preparation support, vi) Poster printing and Poster board rental, vii) Reservations & scheduling of conference room and student lounge areas, viii) Dedicated computer and study spaces for students. The GBS office provides a centralized administrative structure to coordinate the activities of the interdisciplinary, interdepartmental graduate programs within the biomedical sciences. GBS currently encompasses approximately 400 graduate students including MSTP students in PhD training and approximately 350 faculty from 33 departments, 7 Schools, and the affiliated Southern Research Institute and HudsonAlpha Institute for Biotechnology. UAB has provided over 7,000 sq ft to house the Graduate Biomedical Sciences (GBS) Office and programs in the Shelby Interdisciplinary Biomedical Research Building. The GBS Office houses staff of the eight interdisciplinary, interdepartmental GBS thematic graduate programs, including those used by this program, as well as the MSTP, HHMI Med into Grad Fellows Program, Office of Postdoctoral Education, and GBS Data Support Services. It also includes conference, student lounge, and student computer and group study facilities. GBS services include recruitment support, student orientation and social events, financial and personnel management for entering students, GBS website management, training grant data and preparation support, poster production and oversight of conference and study facilities. Institutional annual support of the GBS office, program staff and entering first-year student fellowships exceeds \$3.2M. From this support GBS provides funds to co-sponsor GBS student-led activities (e.g. GBS Student Research Retreat) and sponsors an annual Enrichment Fund competition for GBS theme program's enhancement with recruitment impact.

The GBS Steering and Oversight Committee provide policy and planning oversight of the GBS Office and affiliated programs including for Finance, Curriculum, Faculty Review, Admissions and Graduate Biomedical Student Outreach. GBS recruitment activities on behalf of GBS thematic programs including those used by this program includes GBS and theme websites' development and support, online and hard copy recruitment mailings, GRE Search service contact information for more than 22,000 individuals and participation in national recruitment events including ABRCMS (Annual Biomedical Research Conference for Minority Scientists), SACNAS (Society for the Advancement of Chicano and Native American Scientists) and the annual NIH Graduate and Professional School Fair. GBS also participates in University and regional recruitment events and actively partners with UAB science and technology honors programs and with NIH-funded PREP and K12 IRACDA diversity programs. GBS provides organizational and logistic support of on-campus visits for selected applicants. GBS staff provide theme-specific course support, including rotation poster sessions, manage annual orientation and faculty poster sessions, and organize periodic student social or networking events. GBS, the Office for Postdoctoral Education and the Graduate School and Career Services collaborate to provide an extensive offering of career development and professional skills training seminars, workshops and courses for post-bacc, graduate and postdoctoral trainees. As a recent pilot initiative, GBS Data Support participated with a UAB School of Business-affiliated In Degree program to identify current positions of past graduates via LinkedIn social media participation and will incorporate this program to track graduate outcomes on behalf of graduate programs and training grants

SOM support: Additional support is available through the School of Medicine-Academic Medical Center 21 Strategic Plan process, through which the Committee on Graduate & Postdoctoral Education has been awarded funds to provide matching support of a summer undergraduate research institute, postdoctoral recruitment event and translational training program enhancements. **Most recently (2013), the SOM-AMC will provide \$10K discretionary funds to PI's who successfully renew or acquire new T32 grants, which will be used to enhance the overall training environment in biomedical research.**

TMS program specific commitments: To underscore UAB's previous and ongoing commitment to translational research training programs we note that i) GBS provided significant administrative support for our Med into Grad program ii) SOM and GBS funds were provided to develop a Certificate Program in Translational and Molecular Sciences and the affiliated Eminent Speaker Series (described below) which are flagship components of the current proposal, iii) SOM and GBS funds were provided for Med into Grad trainee research days and iv) since 2011, GBS committed 5 of their graduate school slots per year to the Med into Grad program allowing a doubling of enrollment (from 5 to 10 in 2010, 2012-2013, **Table A**).