

**THE UNIVERSITY OF MICHIGAN
CENTER FOR ORGANOGENESIS**



TRAINEE HANDBOOK

**For NIH and Non-Traditional
Fellowships**

Fall, 2009

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I. MESSAGE FROM THE PROJECT DIRECTOR

Welcome to the Center for Organogenesis (CFO). We are happy to have you join our Research Training Program. Our goal is to help you prepare for an independent research career in the clinical, applied or basic sciences. We know that your individual progress is essential to the continued success of our research program itself. The maintenance of an environment that enriches your scholarly growth is of the utmost importance to us. We encourage you to take advantage of all that is available here. Also, we welcome your input; please suggest ways that we can improve our program.

As Project Director, I have overall responsibility for the Organogenesis Training Grant Program. Your faculty mentor will supervise your day-to-day activities. Kate Barald, Ph.D. serves as faculty ombudsperson.

We hope that you will find this orientation booklet helpful in acquainting yourself with the resources available through the CFO. Retain it for future reference. It includes brief summaries of our research programs, as well as introductions to other trainees. In addition, there are descriptions of facilities and administrative procedures at CFO.

With all best wishes for a rewarding year.

Deborah L. Gumucio, Ph.D.
Project Director, Organogenesis Training Grant Program
Director, Center for Organogenesis
Professor, Cell and Developmental Biology

II. CFO RESEARCH TRAINING PROGRAM

"Organogenesis" unites research in the clinical, basic and applied sciences with a common goal:

To understand the basic mechanisms by which organs and tissues are formed and maintained, and to use this knowledge to create long-lasting artificial organs, improved stem cell therapies and effective organ transplantation systems that will correct acquired and genetic human diseases.

Advances in organogenesis will demand fluent interdisciplinary cross-talk among basic, applied and clinical scientists. Importantly, such cross-talk will accelerate the speed at which important findings in basic research are translated into therapeutic advances in the clinic. At the same time, the constant exchange of information between basic and applied scientists will trigger important improvements in *in vitro* models for the study of organ development, function and disease.

These are exciting times, as the genome projects are providing vast opportunities for functional analysis of genes. It has been estimated that 50% of the genome is devoted to sequences that encode molecules required during processes of organogenesis. But for the vast majority of genes, function has yet to be assigned. Moreover, it is clear that single genes can give rise to multiple protein isoforms, which in many cases, have distinct functions. Thus, discovery of the signaling networks that control development and homeostasis of any single organ is a major challenge for the future. Research in model organisms will provide important clues. Already, work in the fly has correctly identified many of the genes required to make a human heart; work in the frog has led to an understanding of how the embryo knows anterior from posterior and dorsal from ventral; the genetic basis of apoptosis was first identified in the worm; plants are now providing clues to innate immunity; and through the study of mutations in zebrafish, genes have been identified that lead to organ malformation or dysfunction and the human counterparts of these same genes cause similar human diseases and birth defects. The assignment of gene function and the clarification of regulatory networks will continue to benefit from our ability to explore and exploit such model systems.

We are also beginning to see the clinical possibilities afforded by several of the secreted molecules discovered in various developmental systems. Such molecules are now being used to promote the growth of blood vessels in diseased hearts, to allow the culture and amplification of bone marrow stem cells for transplantation, and to create prosthetic bone grafts that will promote local generation of new healthy bone. The study of secreted factors used during development in the embryo (e.g., the Wnt and Hedgehog proteins) are providing new information on the cellular pathways that lead to cancer. Past the gene level, research in tissue engineering is leading to development of new strategies for maintaining, expanding and differentiating stem cells in culture, for healing difficult fractures, for correcting major skeletal defects, and for developing artificial eyes, ears, teeth, kidneys, livers and intestines.

As we look to a future in which the importance of interdisciplinary work in the biomedical sciences is increasingly stressed, it is important to identify strategies to help the next generation of scientists to successfully navigate an increasingly complex research landscape. The training program in Organogenesis was therefore initiated with two major objectives:

- * To provide intellectual and technical training in the field of organogenesis.
- * To promote interdisciplinary thinking by exposing trainees to research that crosses boundaries between the clinical, basic and applied sciences.

The training program in Organogenesis operates within the context of the richly interactive environment provided by the CFO. The activities of the Center are designed to foster the training program and promote the intersection and involvement of trainees with all aspects of Center functions.

Training faculty are chosen from among the 86 full members of the CFO from the following schools and colleges, and disciplinary units:

- * **College of Engineering:** Program in Biomedical Engineering and the Department of Chemical Engineering.
- * **College of Literature, Science and the Arts:** Department of Molecular, Cellular and Developmental Biology
- * **Medical School:** Departments of Biological Chemistry, Cardiac Surgery, Cell and Developmental Biology, Cellular and Molecular Biology, Human Genetics, Ophthalmology and Visual Sciences, Pathology, Pediatrics and Communicable Diseases, Pharmacology, Molecular & Integrative Physiology and the Graduate Program in Neuroscience and Medical Scientist Training Program.
- * **School of Dentistry:** Departments of Oral Medicine, Pathology & Oncology, Periodontics, Prevention and Geriatrics, Biologic and Materials Sciences and the Oral Health Sciences Program.

See Appendix for a list of current participating faculty mentors and research activities of other trainees.

A. Trainee Activities

All predoctoral and postdoctoral trainees are expected to engage in the activities listed below.

1. **Research Project.** The primary activity for each trainee in the program is a research project that is directly related to organogenesis and to the research of the mentor(s), and is supervised by your mentors during the entire period of the training. For predoctoral trainees, this project will relate directly to the dissertation. Postdoctoral trainees will be expected to design a research project that may be an outgrowth of their dissertation research, but will represent a new research direction.
2. **Seminar Series.** Held on Thursday afternoons at 4:00pm during the academic year, the CFO sponsors a seminar series (held in the BSRB Seminar Rooms). All trainees are expected to attend all seminars. As part of the seminar series, training grant fellows will also be encouraged to host certain seminar speakers for lunch. Any expenses incurred by an individual for these activities will be reimbursed by the CFO. Trainees might also be asked to present their training grant research (as part of their progress report) at this seminar series.
3. **Additional Formal Educational Training.** The graduate course entitled "Organogenesis of Complex Tissues - CDB 680/681" is the centerpiece of this training program. It is a semester-long, two-module (three-credit) course that has been offered each fall since 1998. In this course, each module is team-taught by faculty with clinical or research expertise in the topic organ. For each tissue or organ, lectures will integrate several aspects of organogenesis, including morphological and molecular events underlying organ formation; *in vitro* and *in vivo* model systems for the study of these events; parallel pathways for organ formation in model organisms (fly, worm, fish, bird, mouse, and human); adult organ structure and pathology organ regeneration or repair; stem cell systems; carcinogenesis; and artificial organ systems. The objectives of the course are: a) to provide students with a current, in-depth, multidisciplinary view of the processes of organogenesis and b) to highlight target areas for future research. All predoctoral and postdoctoral trainees are required to attend all lectures in one of the two modules of the course during both years of their training. Course registration is not required for training grant or non-traditional fellows.
4. **International Symposium on Organogenesis.** The CFO sponsors a series of International Symposia on Organogenesis. These symposia are designed to expose the faculty, students and

postdoctoral fellows at the University of Michigan to exciting new ideas and expertise in the area of organogenesis. The event begins with the keynote address and reception on Friday evening, and concludes with the symposium proper on Saturday. During the symposium, five to six internationally recognized experts present their current research. A poster session provides opportunities for faculty, fellows and students to display their research. Prizes are awarded to the best student and best postdoctoral poster. The most recent symposium was held on October 5 & 6, 2007 and was focused on "Epigenetics". A future symposium is being planned. All trainees are required to attend the symposium and to present a poster at the poster session. The trainee's registration fee will be paid by the Training Grant.

5. Monthly Trainee Meetings. Trainee meetings are held once a month from 12:00-1:00 p.m. with lunch provided. These meetings are informal and informative and give trainees a chance to share ideas, new findings or problems, or to discuss anything else relevant to their research agenda. Trainees are expected to present their training grant research at these meetings. All trainees are expected to attend these meetings.

6. Participation at Scientific Meetings. Whenever possible, each trainee will be encouraged to present his/her research at a scientific meeting. The Organogenesis training program provides NIH trainees with \$500 per year for this purpose. You must seek approval from the CFO prior to your travel and explain the purpose of the meeting. Additional travel support is available through the Organogenesis Bio-Artography fund (see below).

7. Bio-Artography. Students, postdocs, faculty and staff are encouraged to submit digital images of tissues and cells to the CFO. These images include muscle, fat, ovary, testes, skin, bone, kidneys, sperm, neurons and both human and mouse embryonic stem cells. A panel will select the best images to be matted and framed by the CFO and sold at the Ann Arbor Art Fair and on the Bioartography website (www.bioartography.com). To date, the Bio-Artography sales have grossed around \$60,000.00. Artists who submit images receive 5% of sales from their submissions. The success of this adventure has been outstanding and enthusiasm is high for continuation. Proceeds from the sale of this work will directly support trainees and graduate students in the form of travel grants.

8. Program for Education and Evaluation in Responsible Research and Scholarship (PEERRS). PEERRS is a web-based foundational instruction and certification program for members of the University community engaged in or associated with research. (<http://my.research.umich.edu/peerrs/>) For some faculty, staff and students, PEERRS certification is required, which is obtained by passing a short quiz for each required topic area. All UM faculty, staff and students are invited to use the modules and certification tests to improve their knowledge and awareness of responsible research practices.

All trainees are required to take the module on Foundations of Good Research Practice. All trainees involved in Human Research, whether funded from external or internal sources, or conducted in a course, are required to take the Human Research module. All trainees involved in Animal Research are required to take the Animal Research module. All faculty, staff and students are encouraged to use the modules and certification tests to improve their knowledge and awareness of responsible research practices. The following web-based courses and certification testing are being offered in the following subject areas:

1. **Foundations of Good Research Practice** - publication/authorship, intellectual property, conflict of interest, signatures, plagiarism, misconduct reporting.

2. **Research Administration** - UM procedures/forms, PI responsibilities, pre- and post-award activities, federal regulations, important contacts.

3. **Conflict of Interest** - definitions and recognizing potential conflicts, responsibilities toward students/colleagues, consulting and conflict of commitment, sponsored project and technology transfer issues.

4. **Human Research** – On October 23, 2006, the Human Subjects Research modules in PEERRS were updated. The three modules previously in use have been replaced by two modules, authored by the National Collaborative IRB Training Initiative (CITI):

1. biomedical and health sciences, and
2. social and behavioral sciences.

These cover definition of human subjects research, why human subjects research is regulated, regulatory and ethical responsibilities of the PI, IRB, and University of Michigan.

5. **Animal Research** - principles and regulation for animal care and use, regulatory and ethical obligations of researchers, reporting requirements, obtaining approval.

B. Evaluation Procedure/Progress Report

NIH trainees are evaluated annually by the CFO Training Grant Director. These trainees are expected to submit a progress report for evaluation by the CFO Training Grant Director before their second year fellowship begins. The Director will base her evaluation of each trainee by a written evaluation submitted by the trainee and mentors. Participation by the trainee in the CFO seminars, Organogenesis graduate course, monthly trainee meetings, and other activities, are also a part of the Progress Report. Trainees and mentors will receive notice approximately 2 months before the end of the first year of funding to submit the Progress Report to the CFO.

C. Grievance Procedure

All trainees initially are expected to resolve any emerging difficulties by direct interaction with the assigned mentor who will adhere to the principles of scientific ethics in effect in his or her departmental home, as well as at the CFO. In the event that resolution is not possible at this level, then the trainee may approach the faculty ombudsperson (Dr. Kate Barald). If a resolution is not possible at this level, then the trainee may approach the Training Grant Director (Deborah Gumucio). If resolution still is not possible, the trainee shall next file a written statement to the Training Grant Director stating the problem, the facts which support the allegations, and the disposition of the matter at prior informal stages. The Training Grant Director may seek advice from the CFO Advisory Committee or establish an ad hoc committee for advice on the matter. Before the Director decides a case, she will consult the Office of the General Counsel to assure correct and consistent interpretation of ethical facts. When the Director decides on a matter, the reasons for the decision will be given in writing.

III. CFO ADMINISTRATION AND MISCELLANEOUS PROCEDURES

A. Center for Organogenesis Office and Staff

The CFO office is located in room 2031A BSRB. Office hours are 8:00am-4:30pm Monday-Friday. Becky Pintar is the Center's main point of contact and Training Grant Administrator. Becky's contact info is 936-2499 or rpintar@umich.edu.

B. Tuition

The Training Grant provides funding to cover tuition and registration fees for predoctoral fellows. Other student related fees (student assembly, legal services, and school and college government) cannot be paid by this training grant, and are the trainee's responsibility.

C. Health Care Benefits

All NIH-paid trainees are eligible for health care benefits through the Organogenesis Training Grant. Please note - when a funding change has been made in the trainee's appointment, it often causes a lapse in health care coverage. It is the trainee's responsibility to check with the Benefits Office on a regular basis regarding coverage. Please contact Becky Pintar if you have any questions or problems regarding your health insurance coverage.

D. Stipend Checks and Withholding Taxes

Stipend checks are issued monthly and can be picked up at the main Cashiers Office or direct deposited. If you have a discrepancy in your check, please call Becky Pintar. As a research fellow, Federal and State income taxes will not be withheld from monthly stipend checks. However, the stipend is considered taxable income. It is the responsibility of the trainee to file estimated taxes quarterly, or to make other arrangements regarding withholding taxes. The trainee will not receive a W-2 statement from the University of Michigan.

E. Hosting and Travel Reimbursements

Hosting and travel reimbursements will be made to trainees for research-related expenses. Approved travel can be reimbursed if all expenses are documented with receipts. Research-related purchases and all travel requests must be approved by the Training Grant Director in advance and must be documented with receipts. Becky Pintar will handle all reimbursements. If needed, a travel advance can be prepared to attend scientific meetings.

F. Research Cores Supported by the Center for Organogenesis

1. Morphology Core

The Morphology Core of the Center for Organogenesis was established in 1996 and is under the direction of Dr. K. Sue O'Shea. The Core maintains a large collection of staged mouse embryo cryostat sections in the saggital plane. Other section planes can be specifically ordered. In addition, selected adult mouse tissues are available for purchase, sectioned or whole. The Core also provides technical support for microscopy, tissue processing and embedding, H&E staining and real time PCR. The Core can also assist with embedding and sectioning of other embryos or tissues and with processing of images using Adobe PhotoShop. Finally, the Core can provide RNA from staged mouse embryos and tissues of interest.

For more information, please contact Maria Ripberger at 647-9021 ripbermc@umich.edu. Website: <http://www.med.umich.edu/omc/>

2. Human Embryonic Stem Cell Core

The Michigan Center for hES Cell Research was established in 2002 within the Center for Organogenesis with generous funding from the Medical School's Endowment for the Basic Sciences.

In 2003, the Center was awarded an Exploratory Center Grant for Human Embryonic Stem Cell Research from the National Institutes of Health (1 P20 GM069985-01) to expand and further support hES cell research at the University. The mission of the hES Cell Center is to provide training, technologies, and education in human embryonic stem cell biology.

1. A tissue culture Core Facility established to maintain hES cell lines, that provides quality control and shares expertise, protocols, and reagents within the U of M scientific community. The Core is also engaged in basic research under the direction of the Core Director, Dr. K. Sue O'Shea.

2. The Core Facility provides coursework and hands on training in the culture of human embryonic stem cells for faculty, staff, and students.

3. Graduate coursework, seminar programs, and an annual symposium have been established as educational opportunities for the scientific community.

4. Education of the general public on the facts and potential benefits of human embryonic stem cell research is also part of our goal. The Center participates in community outreach and provides educational opportunities through a variety of programs.

More than 40 scientists are active participants in the Center for hES Cell Research. The research ranges in scope from studies of the fundamental biology of stem cells and the human embryo, to understanding the development of all the organ systems in the body, to therapeutics and bioengineering of tissues and organs.

For more information regarding the hESC Core, please contact Crystal Pacut at 763-5557 or cpacut@umich.edu.

IV. APPENDIX

A. Research Activities of Current and Recent Trainees

Predoctoral Fellows

Ferdous Barlaskar, Department of Cellular and Molecular Biology, 10/1/06 – 8/31/09. (Mentor: Gary Hammer, Co-mentor: Trachette Jackson). Ferdous received a B.S. degree with honors in Human Biology from Michigan State University. He is currently in the MSTP dual degree program.

Research Project: **The Role of TGF β Ligands in Adrenocortical Tissue Maintenance and Differentiation.** Our laboratory is interested in understanding the adrenal-specific role of several ligands of the TGF β family such as activin, inhibin and TGF β 2. The means by which these ligands function in concert to mediate adrenocortical development and maintenance is uncertain. I have chosen to initially approach this question with mathematical modeling to help bridge the complex and diverse functions of these ligands in adrenal organogenesis. The ensuing basic molecular and developmental science to validate the mathematical model formulations will be carried out subsequently. The mathematical modeling of this interdisciplinary research proposal will guide my experimental methodology, and in turn, my experimental data will validate the mathematical equations. Ultimately, this approach will facilitate my final goal of ascertaining how these various TGF family ligands contribute to adrenocortical development.

Christopher Chou, Department of Human Genetics (MSTP), 9/1/09 – present. (Mentor: Tom Glaser, Co-mentor: Donna Martin). Chris received a Bachelor of Science degree in Bioengineering from the University of California @ Berkeley.

Research Project: **General Analysis of Two Novel Cases of Anophthalmia.** Over the past two years our lab has been engaged in a study involving a Caucasian family where the MAC disorder is transmitted as an autosomal dominant trait with incomplete penetrance. The proband is affected with bilateral anophthalmia as are several other more distant relatives in this large pedigree of 92 members. A number of other members show microphthalmia and colobomas. We have used linkage analysis to narrow down the region that we are investigating and have so far focused our efforts there. A second unrelated case our lab has been investigating involves a male child affected by sporadic bilateral anophthalmia with a left orbital teratoma. The teratoma is comprised mostly of chondrocytes with some neuronal remnants. Karyotypic analysis reveals a normal 46,XX karyotype thus defining a case of XX sex-reversal. He also presents with unilateral cryptorchidism, and hypoplasticity of the cerebellar vermis and corpus callosum (Dandy-Walker Syndrome). Our studies here are focused on trying to identify the genetic causes of the MAC phenotypes in both cases.

Ann Grosse, Department of Cellular and Molecular Biology, 9/1/08 – present. (Mentor: Deborah Gumucio, Co-mentor: Ben Margolis). Ann received her Bachelor of Science degree in Biochemistry from Denison University in Granville, OH.

Research Project: Understanding the Role of Wnt5a in Epithelial Polarity and Organization During Intestinal Organogenesis. My research project is the study of both intestinal organ development as well as abnormal intestinal growth. The Wnt5a null mouse has obvious defects in processes of villus emergence and intestinal length; further study of this model will likely reveal critical new information not only about intestinal organogenesis, but potentially also leading to further understanding of congenital short bowel syndrome.

Kenneth Krill, Cellular and Molecular Biology Program (MSTP), 9/1/09 – present. (Mentor: Gary Hammer, Co-mentor: John Kim). Ken received a B.S. degree in Biology from the University of Michigan.

Research Project: Study on the Role of Dicer in Adrenal Development and Maintenance. My project aims to study the role of microRNAs in adrenal development and maintenance using an in-vivo model. Due to the very nature of microRNAs – their abundance, redundancy, and potentially pleiotrophic effects – fully deciphering their role in organ development will require expertise from multiple disciplines ranging from molecular biology to bioinformatics. Furthermore, microRNA research has been rapidly expanding in recent years, and numerous examples of microRNA involvement in human disease have been described, shifting these small RNAs from esoteric cellular curiosities to targets of genuine clinical interest. Current diseases of the adrenal gland pertinent to organ development and maintenance include those involving organ dysfunction, dysplasia, and neoplasia. There is currently little information regarding the role of microRNAs in these adrenal diseases. We therefore foresee this proposal as an initial step in furthering the understanding of these small RNAs in not only the development of the adrenal, but its pathogenesis as well.

John Petrie, Department of Molecular and Integrative Physiology, 9/1/08 – 8/31/09. (Mentor: Ormond MacDougald, Co-mentor: Ken Cadigan). John received a B.S. degree in Genetics from the University of Georgia/Athens in 2004.

Research Project: The Roles of Wnt6 and Tcf712 in Adipocytes. The long-term goal of my research project is to understand how Wnt signaling inhibits adipogenesis. The Wnt/ β -catenin pathway stabilizes cytosolic β -catenin, which then accumulates in the nucleus and forms dimers with TCF/LEF transcription factors to activate Wnt target genes. Wnt/ β -catenin signaling is important in adipocyte development, as Wnt1, Wnt3a, and Wnt10b inhibit adipogenesis, and dominant-negative TCF4 promotes adipogenesis by blocking Wnt signaling. Wnt6 and Tcf712 (TCF4) are highly expressed in murine adipose tissue and Tcf712 variants are strongly associated with type 2 diabetes and β -cell function in humans, so I have directed my efforts towards examining their role in adipocyte biology. I have discovered Wnt6 is expressed in preadipocytes, is suppressed during adipocyte differentiation, and is a potent inhibitor of adipogenesis *in vitro*. Tcf712 is expressed in both cultured preadipocytes and adipocytes, suggesting it can function outside of differentiation. I have shown Wnt6 and Tcf712 mRNA levels are inversely correlated with body weight and adipose depot mass in mice. Therefore, I hypothesize that Wnt6 and Tcf712 are endogenous inhibitors of adipogenesis and Tcf712 modulates insulin sensitivity in adipocytes.

Emily Petty, Molecular, Cellular and Developmental Biology Program, 9/1/09 – present. (Mentor: Gyorgyi Csankovszki, Co-mentor: Yali Dou). Emily received a Bachelors Degree in Biology and Music from Central Michigan University.

Research Project: Regulation of *C. elegans* Dosage Compensation by Histone Variant H2A.Z/HTZ-1. The proposed work centers on the widely conserved chromatin components, histone variant H2A.Z and the Set1 histone methyltransferase complex (Set1C). H2A.Z is essential for the development of all multicellular eukaryotes tested. Set1-like complexes methylate histone H3 at lysine 4, a mark important for proper gene activation in all species studied. We are studying these components in the developmental process of dosage compensation using the model organism *C. elegans*. Dosage compensation equalizes sex-linked gene expression between sexes and is an essential transcription

program initiated at a precise time in the development of worms, flies, and humans. Previously we found that H2A.Z functions in *C. elegans* dosage compensation. We hypothesize the *C. elegans* Set1C coordinates with H2A.Z to promote proper dosage compensation and acetylation of H2A.Z is important for its dosage compensation function. We are taking an interdisciplinary approach to test our hypotheses by combining genetic, cytological, and biochemical approaches. This project will contribute to our understanding of the regulation of coordinated changes in gene expression at the fundamental level of chromatin.

Kathryn (Kaia) Skaggs, Neuroscience Program, 9/1/08 – present. (Mentor: Donna Martin). Kaia received an M.S. degree in the UM Neuroscience Program in 2006.

Research Project: Regulation of Spinal Interneuron Development by the Olig2-related Transcription Factor Bhlhb5. This project proposes to study how neural stem and progenitor cells give rise to motor neurons (MNs) and interneurons (INs) in the spinal cord. Errors in the process of assigning specific cell-type identity to the progenitor cells that generate neuronal and glial cell types in the CNS during development result in devastating congenital abnormalities. Loss of survival or function of these cell types underlies neurological conditions such as spinal ataxias, spastic disorders, spinal muscular atrophies, ALS, and Kennedy's disease as well as spinal cord injuries. While a great deal of attention has been focused on describing the formation and function of MNs, recent studies have shown that several classes of excitatory and inhibitory spinal INs that regulate MN activity are critical for normal motor functions. The mechanisms that lead to IN generation in most regions of the CNS, however, are not well understood. In my proposed research, I will examine the function of a newly described transcription factor, Bhlhb5, in the generation of spinal INs. An understanding of how factors such as Bhlhb5 control the differentiation of specific IN cell types should yield insights into developmental mechanisms that lead to proper CNS function as well as causes of congenital abnormalities. In addition, this line of research may help to identify therapeutic targets to ameliorate these defects, and provide a foundation for current and future studies seeking to use stem cell-based therapies to treat neurological injuries and diseases. The experimental approaches proposed span the disciplines of genetics, cellular and molecular biology, biochemistry, and developmental biology to study mechanisms and cellular interactions that permit embryonic stem cells to generate the distinct cell types and functional circuits in the spinal cord necessary for coordinated movement.

Christina Swanson, Cell and Developmental Biology, 10/1/07- 9/30/09. (Mentor: Scott Barolo, Co-mentor: Patricia Wittkopp). Christina received an M.S. degree in Cell & Developmental Biology from the University of Michigan in 2006.

Research Project: Structure, Function, and Evolution of a Notch- and EGFR-regulated Eye Enhancer. My project focuses on transcriptional regulation of the *Pax2 sparkling* enhancer during *Drosophila* eye morphogenesis. We are taking a highly interdisciplinary approach, incorporating genetics, biochemistry, bioinformatics, and evolutionary biology into our experimental design. I will be identifying novel regulators binding within *sparkling*, which will provide more information about the regulation of *Pax2* expression and cone cell specification during *Drosophila* eye development. In addition, I will be investigating the role of enhancer structure in gene expression, including how the spatial organization of *sparkling* affects the pattern of gene expression. This portion of my project will add to our understanding of the structure and function of enhancer elements *in vivo*.

Postdoctoral Fellows

Melih Acar, Ph.D., Life Sciences Institute, 9/1/08 – 8/31/09. (Mentor: Sean Morrison, Co-mentor: Laurie McCauley). Melih received his Ph.D. degree in 2006 from Baylor College of Medicine, Program in Developmental Biology.

Research Project: The Role of Megakaryocytes in the Regulation of Hematopoietic Stem Cell Function. I hypothesize that megakaryocytes are a critical component of the hematopoietic stem cell (HSC) niche that regulates HSC maintenance through cell-cell interactions and secreted factors. This interaction is essential for proper HSC localization and homeostasis. In collaboration with Dr. McCauley's laboratory in the Dental School, we will test this hypothesis and whether effects of megakaryocytes in HSC maintenance are independent of effects on bone formation. This work could fundamentally change models of the HSC niche by implicating megakaryocytes in HSC regulation for the first time. By focusing on the interaction of cells in different lineages and tissues (hematopoietic and bone), this work could provide new insights into the complex interplay of progenitors from different tissues.

SunJung Kim, Ph.D., Department of Internal Medicine, 10-1-09 – 9/30/10. (Mentor: Yuan Zhu). Sun Jun received a Ph.D. degree in 2008 from Seoul National University, Korea.

Research Project: The Role of the Tumor Suppressor Gene Adenomatous Polyposis Coli (APC) in the Development of the Cerebral Cortex. During the cortical development, regulation of proliferation and differentiation of neural stem cells (NSCs) and their progeny is essential for precisely establishing cortical lamination. The purpose of this research is to seek fundamental knowledge about how NSCs give rise to the highly organized six-layer cortex and if dysfunction of certain genes affects cortex development. I hypothesize that Adenomatous Polyposis Coli (APC), a negative regulator in β -catenin/Wnt signaling, is essential for the differentiation of NSCs to intermediate neural progenitor cells (INPs), and deregulated high levels of β -catenin expression causes disruption of cerebral cortex in Apc-deficient brains.

Christopher LaPensee, Ph.D., Department of Molecular and Integrative Physiology, 9/1/09 – present. (Mentor: Jessica Schwartz, Co-mentor: Jiandie Lin). Chris received his Ph.D. degree from the University of Cincinnati in 2006.

Research Project: The Role of Bcl6, a Novel Transcriptional Regulator, in Adipogenesis. Adipose tissue growth involves an increase in adipocyte size and the formation of new adipocytes from precursor cells during a process called adipogenesis. Understanding the molecular basis of adipogenesis may lead to the development of therapies to treat adipose tissue-related disorders, such as obesity, diabetes, and metabolic syndrome. The adipogenic program involves coordinated transcriptional activation and repression of adipocyte genes. B cell lymphoma 6 (Bcl6) is a potent transcriptional repressor that well-studied for its role in the regulation of gene expression during B cell differentiation in germinal centers, but its actions in non-lymphoid tissues are poorly understood. My laboratory recently detected Bcl6 in adipocytes. My finding that Bcl6 expression increases in differentiating adipocytes suggests novel transcriptional mechanisms for regulation of genes that change during adipogenesis. I am developing knockdown and overexpression models in vitro and in vivo in order to advance our understanding of the role of Bcl6 in genetic programs associated with adipogenesis.

Yan Li, Ph.D., Department of Periodontics and Oral Medicine, School of Dentistry, 10/1/09 – 9/30/10. (Mentor: Renny Franceschi, Co-mentor: Steven Goldstein). Yan received the Ph.D. degree in 2000 from Shandong Agricultural University in China.

Research Project: Mechanism of Mechanical Load-induced Gene Regulation in Osteoblast.

Bone has the unique property of being able to modify its structure and mechanical strength in response to dynamic loads. Osteoblasts and osteocytes in bone are surrounded by interstitial fluid within the medullary cavity and bone canaliculi. During dynamic loading of bone, displacement of interstitial fluid exposes cells to fluid flow shear stress (FFSS), which activates genes necessary for osteoblast differentiation and bone formation. Essentially nothing is known about how these mechanical signals are

translated into changes in osteoblast gene expression/differentiation. Our objective in this study is to discover a mechanism of mechanical load-induced gene expression in osteoblasts. We hypothesize that mechanical signal stimulates protein kinase cascades including ERK/MAPK, resulting in translocation of the kinases to the nucleus where it binds RUNX2, a transcription factor in bone development, previously bound to regulatory regions of specific genes. From these chromatin sites, kinases initiate changes of chromatin structure by phosphorylating chromatin substrates including RUNX2 and histones as well as by acetylating histone leading to increase transcription.

Eiichi Miyasaka, M.D., Department of Surgery, 7/1/08 – present. (Mentor: Daniel Teitelbaum, Co-mentor: Deborah Gumucio). Eiichi received his M.D. degree from the University of Michigan in 2006.

Research Project: Distraction Enterogenesis: Molecular Mechanisms of Intestinal Growth Control.

Short-bowel syndrome (SBS) is a condition where the small intestinal length is less than that required for proper nutrient absorption needed for survival. The condition can occur in pediatric and adult populations, and may be due to congenital processes, or acquired through the loss of large amounts of small intestine due to inflammatory conditions or ischemic events. A novel treatment method under investigation is lengthening of the bowel through distraction forces. Preliminary porcine data has shown promise in that the bowel subjected to distraction forces increased in length, and had a proportionately increased absorptive capacity as well. However, the mechanisms which promote distraction enterogenesis are unknown. Preliminary data showed a significant up-regulation of several factors including Indian hedgehog, desmin and vimentin in these lengthened segments. The increased desmin and vimentin potentially supports a Wnt-mediated signalling pathway, as these factors are exclusively expressed in the mucosa of developing intestine during increased Wnt expression. The marked change in expression of these factors may help drive the formation of the crypt-villus axis. My projects will attempt to quantify the effects of distraction forces by examining certain morphometric parameters including crypt depth, villus height, and mucosal thickness. Functional capacity will also be examined using an Ussing chamber. We will also be examining the optimal ways to apply distraction forces to the bowel in cooperation with the Department of Engineering. After quantifying the effects, expression of growth-related factors will be tested after disrupting iHH expression. Other projects include identifying changes in cytokine expression and extent of regulatory T-cells in mice receiving TPN.

David Parker, Ph.D., Department of Cell and Developmental Biology, 2/1/09 – 9/30/09. (Mentor: Scott Barolo, Co-mentor: David Lubensky. David earned his Ph.D. in 2006 from UM/Molecular, Cellular and Developmental Biology.

Research Project: Mechanisms of Tissue-Specific Responses to Hedgehog Signaling. Cell signaling pathways such as Hedgehog (Hh), Notch, Wnt, BMP/TGF- β , and RTK/Ras/MAPK regulate cell fate, cell survival, motility, and proliferation during animal development. Signaling pathways act primarily by controlling the expression of specific target genes in signal-responding cells. They do so by regulating the activity of specific transcription factors (TFs) in the nucleus. These signal-regulated TFs bind to specific sites within regulatory DNA sequences called enhancers, located near pathway target genes. Some target genes respond to their associated signal in every developmental context. However, most target genes respond in a tissue specific manner to signaling, allowing complex gene expression patterns to be generated by a single signal transduction pathway throughout development. The transcriptional effects of Hh signaling are mediated by the Gli family of TFs, of which *Drosophila* has a single member called Ci. Ci/Gli proteins preferentially bind the DNA sequence TGGGTGGTC both in vivo and in vitro, and this sequence has been used repeatedly in searches for new Hh target genes. Our data suggest that tissue-specific Hh enhancers require low affinity, non-consensus Ci/Gli binding sites and only universally responding Hh enhancers require high affinity consensus Ci/Gli sites. This mechanism may be general, as several *Drosophila* enhancers identified for known tissue-specific responders to Hh signaling contain low affinity Ci sites. In addition to expanding our study to more tissue-specific Hh enhancers, we hope to combine mathematical modeling with in vivo approaches to further explore this novel mechanism of the Hh transcriptional response.

Rajesh Ramachandran, Ph.D., Molecular and Behavioral Neuroscience Institute, 9/1/08-8/31/09. (Mentor: Daniel Goldman, Co-mentor: Jack Parent). Raj received his Ph.D. degree in 2005 from the Centre for Cellular and Molecular Biology in Hyderabad, India.

Research Project: An Investigation on the Role of Transcription Factors Ascl1a and Zic 2b, and RNA Binding Protein Lin 28 in Retinal Regeneration. My project aims to understand the molecular mechanisms underlying successful regeneration of an injured retina. These mechanisms may, in part, recapitulate developmental mechanisms of retinogenesis; however because retinal repair is taking place in an adult environment, novel mechanisms specific to adult regeneration are likely to be revealed. We anticipate that this work will impact the ability to maintain and repair a damaged or diseased retina and may also benefit in understanding mechanisms of neural repair in the other CNS areas. Zebrafish are used as a model system for this study because of their robust regenerative powers and the ease of applying molecular genetic techniques to this organism. Our long-term goal is to apply to mammals what we learn from studying regeneration in zebrafish.

Therese Roth, Ph.D., Department of Cell & Developmental Biology and Life Sciences Institute, 9/1/08 – present. (Mentor: Yukiko Yamashita). Therese received her Ph.D. degree in 2007 from the University of Michigan, Department of Cell & Developmental Biology.

Research Project: The Role of Insulin Signaling in the Regulation of Germline Stem Cells. A steady supply of adult stem cells is critical to maintain differentiated cells at the appropriate level of homeostasis. Stem cells can divide asymmetrically so that one daughter cell remains undifferentiated to maintain the stem cell population while the other begins to differentiate. If the stem cell population is depleted, differentiated cells cannot be replaced, while overproliferation of stem cells can cause tumors to develop. An increase in tumor formation and cancer is associated with aging. This research project which studies the effect of insulin signaling on germline stem cells, is at the interface of stem cell biology, aging and cancer. There is a relationship between insulin signaling and aging/longevity that is inversely correlated with reproductive fitness. Conditions which are favorable for increased longevity, for example nutrient deficiency, often result in decreased reproduction. Conversely, increased numbers of progeny are correlated with decreased lifespan. The *Drosophila* male germline stem cell niche is an ideal model system to use to study stem cell interaction because the niche and germline stem cells are easily identified and the cell cycle pathway has been well-characterized. We are able to follow the stem cell niche both in fixed testes and varying ages as well as live cell imaging. Conclusions reached through studying this pathway may then be used as a basis to study stem cell-niche interactions in other model systems.

Former Trainees on the Organogenesis Training Grant

Trainee Name & Training Period	Department	Research Mentors	Research Topic	Current Status
BAI, Shoumei Postdoc 4/16/07-4/15/09	Biochemistry	Kerppola Han	The Roles of NFAT:Fos-Jun and NFAT:FOXP Transcription Regulatory Complexes in Pathological Hypertrophic Growth of Cardiomyocytes	Postdoctoral Fellow, UM Biochemistry Department
BANK, Lisa Postdoc 1/1/03-7/31/03	Molecular, Cellular and Developmental Biology	Bodmer Metzger	Genetic Analysis of Cardiac Function During Aging in the Fly Model	Visiting Lecturer, Biology Dept., Eastern Michigan University, and Research Fellow, UM Cell & Developmental Biology Dept.
BERRY, Jennifer Postdoc (MD Fellow) 7/1/00-6/31/01	Cardiac Surgery	Bolling Traynor	Delta Opioid Receptors and Myocardial Tolerance to Ischemia and Reperfusion in Normal and Failing Myocardium	Faculty member, Stanford University
BREUER, Debra Predoc 4/1/98-3/31/99	Ophthalmology and Visual Sciences	Swaroop Deretic	Understanding the Mechanism of Retinal Degeneration in X-linked Retinitis Pigmentosa	Postdoctoral Fellow, Department of Cell & Molecular Biology, University of Hawaii @ Manoa
CESENA, Teresa Predoc 12/1/03-11/30/05	Cellular and Molecular Biology	Schwartz Kwok	The Role of Acetylation of C/EBP β in Adipocyte Differentiation	Postdoctoral Fellow, UM Life Sciences Institute
CHA, Hyuk Chol Predoc 9/1/04-8/31/06	Molecular and Integrative Physiology	MacDougald Gumucio	C/EBP α Phosphorylation in the Development of Adipocyte Response to Insulin	Graduate Student, UM, Molecular and Integrative Physiology
CHEN, Victor Predoc 9/1/02-8/31/04	Biomedical Engineering	Ma Franceschi	Tailoring Architectural and Material Properties of Nano-Fibrous Poly (L-Lactic Acid) Scaffolds for Bone Tissue Engineering	High School chemistry teacher, Redford, MI
CHENG, Hong Postdoc 8/1/06-2/10/08	Ophthalmology and Visual Sciences	Swaroop Dressler	Identification of Candidate Genes and their Roles in Photoreceptor Differentiation	Postdoctoral Fellow, NIH/NEI
CORRADETTI, Mike Predoc 12/1/03-11/30/05	Cell and Molecular Biology	Guan Ginsburg	Evidence for a Common Etiology for Tuberous Sclerosis Complex and Peutz-Jehgers Syndrome	Medical Student, UM
CUI, Wilson Predoc 9/1/04-8/31/06	Cellular and Molecular Biology	Kuwada Isom	Genetic Analysis of Neural Circuit Function and Behavior in Zebrafish	Medical Student, UM
ESTRADA, Lourdes Postdoc 4/1/99-3/31/01	Human Genetics	Gorski Long	Role of Fgd1/Cdc42 Signaling Pathways in Bone Growth and Differentiation	Research Assistant Professor of Cancer Biology, Vanderbilt University
FOGG, Vanessa Postdoc 4/21/03-9/20/05	Internal Medicine	Margolis Weiss	Analysis of Pals1-associated Protein Complexes in the Development of Cell Polarity	Full-time Mother
GAGNE, Jennifer Postdoc 4/1/06-7/31/06	Molecular, Cellular and Developmental Biology	Clark Margolis	The Roles of the Protein Phosphatase Type 2c Proteins, POL and PLL1 in Arabidopsis Thaliana Stem Cell Regulation and Embryo Development	Postdoc Fellow, UM, Molecular, Cellular and Developmental Biology Program
GAO, Jingtong Postdoc 4/1/01-3/31/03	Pediatrics and Communicable Diseases	Gorski Ellis	Developmental and Genetic Analysis of fgd-1, the C elegans Ortholog of Human FGD1.	Research Assistant, Pharmacy & Health Sciences, Wayne State University

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GERIN, Isabelle Postdoc 10/1/03-9/30/05	Molecular and Integrative Physiology	MacDougald	FOX Transcription Factors and Their Role in Adipocyte Differentiation and Metabolism	Postdoc Fellow, UM, Molecular and Integrative Physiology
HERZBERG, Ian Postdoc 4/20/99-4/19/00	Pharmacology and Neurology	Isom MacDonald	Beta-2 Subunits of Neuronal Voltage-Gated Na ⁺ Channels: Functions in Channel Gating and Mechanisms of Channel Targeting and Localization	Applications Specialist, ALA Scientific Institute, Westbury, New York
HINKLE, Karen Predoc 4/1/00-3/31/02	Physiology	Samuelson DelValle	Mechanisms of Gastrin-induced Maturation of Parietal Cells	Assistant Professor, Department of Biology, Norwich University, VT
HUANG, Liyue Postdoc 4/29/00-4/28/01	Biology	Denver Hitchcock	Molecular Mechanisms of Thyroid Hormone Actions on Cell Proliferation, Programmed Cell Death, and Cell Differentiation and Maturation During Metamorphosis of <i>Xenopus Laevis</i>	Team Member, Cayman Chemical, Ann Arbor, MI
KEARNEY, Jennifer Postdoc 3/1/98-2/28/99	Human Genetics	Meisler Isom	Targeting and Subcellular Localization of the Sodium Channel Scn8a	Assistant Professor of Medicine, Vanderbilt University
KLINEDINST, Susan Predoc 3/1/02-6/30/02	Molecular, Cellular, and Developmental Biology	Bodmer Kerppola	The Functions of the GATA Factor <i>Pannier</i> and its Partner <i>U-shaped</i> in Specifying the <i>Drosophila</i> Heart.	Postdoc Fellow, Brandeis University
LANNING, Nate Predoc 10/1/06-9/30/08	Cellular and Molecular Biology	Carter-Su Colletti	Regulation of Liver Regeneration Through Interaction of the Growth Hormone and TGF- β Signaling Pathways	Graduate Student, UM CMB Program
LAY, Jean Predoc 7/1/97-6/30/98	Physiology	Samuelson O'Shea	Cholecystokinin Expression and Intestinal Endocrine Cell Differentiation	Self-employed at Biobase (formerly Incyte Corp)
LEE, Cheong Jun (CJ) Postdoc (MD Fellow) 7/1/06-6/30/08	Surgery	Simeone Gumucio	Identification and Characterization of Pancreatic Cancer Stem Cells	Surgery Fellow, UM Surgery Department
MADISON, Blair Predoc 10/1/01-9/30/03	Cellular and Molecular Biology	Gumucio Mortensen	Role of Wnt Signaling in Intestinal Organogenesis	Vice President, Transposagen Biopharma-ceuticals, Research Division, Philadelphia, PA
MICHELE, Daniel Predoc 3/1/98-2/29/99	Physiology	Metzger Chamberlain	Tropomyosin Mutations and Hypertrophic Cardiomyopathy	Assistant Professor, UM Dept. of Integrative & Molecular Physiology
MORTLOCK, Doug Postdoc 7/1/97-6/30/98	Human Genetics	Innis Chen	Genetics of Vertebrate Digital Arch Foundation	Assistant Professor, Dept. of Molecular Physiology & Biophysics, Vanderbilt University, Nashville, TN
NIKOLOVSKI, Janeta Predoc 9/1/97-8/31/98	Chemical Engineering	Mooney Bonadio	Implantation Device for Gene Therapy of Hemophilia B	Senior Scientist, Johnson & Johnson Co.
NING, Yangmin Postdoc 7/1/97-9/19/97	Human Genetics	Robins Markovitz	Identification of the Non-Receptor DNA Binding Proteins Required for an Androgen-Specific Response	Research Fellow, UM, Human Genetics
OLIVER, Edward Predoc 4/1/01-3/31/03	Human Genetics	Glaser Hitchcock	Belly Spot and Tail: Phenotypic Characterization and Gene Identification	M.D. Radiology Resident, University of Pennsylvania
O'MALLEY, Heather Predoc 9/1/05-6/29/07	Pharmacology	Isom Meisler	Role of Sodium Channel β 2 Subunits in Neuroprotection	Health Science Research Assistant, UM, Pharmacology

Trainee Name & Training Period	Department	Research Mentors	Research Topic	Current Status
OMINSKY, Michael Predoc 3/1/00-2/28/02	Biomedical Engineering	Goldstein Roessler	Interactions Between Mechanical Loading, Gene Transfer, and Gene Expression <i>In Vitro</i>	Senior Scientist, Dept; of Metabolic Disorders, Amgen Corp., Thousand Oaks, CA
PARKER, David Predoc 9/1/02-8/31/04	Molecular, Cellular and Developmental Biology	Cadigan MacDougald	A Transcription Factor Regulating the Alpha-1 Tubulin Promoter During CNS Development and Regeneration in Zebrafish	Postdoc Fellow, UM, Cell and Developmental Biology
PIEKE-DAHL, Sandra Postdoc 4/20/00-4/19/02	Ophthalmology and Visual Sciences	Hitchcock Swaroop	A Murine Model of Retinal Coloboma	Research Instructor, Dept. of Pharmacology, University of Texas Health Science Center; Director, Behavioral Core Facility, Barshop Institute for Aging & Longevity Studies, San Antonio, TX
PRINDLE, Marc Predoc 9/1/02-8/31/04	Cellular and Molecular Biology	Dressler Thiele	The Role of PTIP in DNA Damage Repair and Cell Cycle Control	Pending postdoc fellowship at Univ. of Washington
PUTNAM, Andrew Predoc 9/1/99-3/31/01	Chemical Engineering	Mooney Hunt	A Microscopic Study of Mechanotransduction: Microtubule Behavior in Response to Externally-Applied Mechanical Forces	Assistant Professor, Dept. of Biomedical Engineering and Chemical Engineering & Materials Sciences, University of California @ Irvine
SCHANER, Philip Predoc 9/1/99-8/31/01	Cell and Developmental Biology	Gumucio Boxer	Transcriptional Regulation of Pym in the Context of Neutrophil Mediated Inflammation	Radiation Oncology Resident, University of Alabama Hospital
SHILLINGFORD, Mike Postdoc (MD Fellow) 7/1/04-6/30/06	Molecular and Integrative Physiology and Surgery	Metzger	Development of Large Mammalian Models of Cardiac Failure and Investigating the Efficacy of Gene-based Strategies for Disease Remediation	Surgery Resident, University of Florida
SLAWNY, Nicole Predoc 3/1/02-9/13/02	Cell and Developmental Biology	Csete Mortensen	Skeletal Muscle Satellite Cell Adipogenesis	Graduate Student, UM, Cell and Developmental Biology
SONG, Mi Hye Postdoc 4/29/01-4/28/03	Molecular, Cellular and Developmental Biology	Kuwada Morrison	Phenotypic Analysis and Cloning of the Zebrafish <i>curly fry</i> Mutation that Deregulates Proliferation in the Brain	Postdoctoral Fellow, NIDDK/NIH Centrosome regulation in <i>C. elegans</i> embryo
STEINKAMP, Mara Predoc 9/1/04-8/31/06	Human Genetics	Robins Merajver	Elucidating the Role of the Androgen Receptor in Mammary Gland Development and Breast Cancer	Graduate Student, UM Human Genetics
STRAIGHT, Samuel Postdoc 4/20/99-4/19/00	Internal Medicine	Margolis Dressler	The Role of mLin-7 in Protein Targeting	Research Lab Specialist, UM, Microbiology & Immunology
TABOAS, Juan Predoc 4/1/01-3/31/03	Oral Medicine, Pathology, Oncology	Krebsbach Hollister	Stem Cell Lineage Control Via Mechanical Force	Postdoctoral Fellow, Cartilage Biology and Orthopaedics Branch, NIAMS, NIH
UHLER, Jennifer Postdoc 3/1/02-2/28/03	Pathology	Mellerick Markovitz	The Role and Downstream Targets of the Drosophila Nk6 Homeobox Gene	Postdoctoral Fellow Cancer Research Institute, UK
VALVERDE, Roldan Postdoc 4/26/99-4/25/01	Biology	Denver Seasholtz	Neuroendocrine Control of Amphibian Metamorphosis	Assistant Professor, Dept. of Biological Sciences, Southeastern Louisiana University, Hammond, LA

Trainee Name & Training Period	Department	Research Mentors	Research Topic	Current Status
VELDMAN, Matthew Predoc 1/1/02-12/31/03	Neuroscience Program	Goldman Raymond	Mechanisms Underlying Central Nervous System Development and Regeneration	Graduate Student, UM, Biology
XIAO, Guozhi Postdoc 3/1/98-2/28/00	Periodontics, Prevention, & Geriatrics	Franceschi Kerppola	Extracellular Matrix Regulation of <i>Osf2/Cbfa1</i> , a Transcription Factor Controlling Osteoblast-Specific Gene Expression in Bone Formation	Assistant Professor, Dept. of Medicine, University of Pittsburgh
YALLOWITZ, Alisha Predoc 10/1/06-9/30/08	Cell and Developmental Biology	Wellik Dressler	Anterior-Posterior Patterning of the Nephrogenic Mesenchyme by <i>Hox</i> Genes	Graduate Student, UM CDB
YANG, Steve Hoseong Predoc 9/1/05-8/31/07	Dermatology	Dlugosz Gumucio	Crosstalk Between Hedgehog and Wnt Pathways During Epithelial Bud Development and Tumorigenesis	Graduate Student, UM, Cell & Molecular Biology Program
ZACHARIAS, William Predoc 10/1/06-9/30/08	Cell and Developmental Biology	Gumucio Merchant	Identification of the Role of Hedgehog Signaling in Intestinal Villus Integrity and Smooth Muscle Development	Graduate Student, UM, CDB

B. List of Training Grant Faculty**Kate F. Barald, Ph.D.**

Professor of Cell and Developmental Biology, Professor, of Biomedical Engineering, Associate Director of the Program in Biomedical Sciences

Scott Barolo, Ph.D.

Assistant Professor, Department of Cell and Developmental Biology

Kenneth Cadigan, Ph.D.

Assistant Professor, Department of Molecular, Cellular and Developmental Biology

Sally Camper, Ph.D.

Professor and Chair, Department of Human Genetics; Professor of Internal Medicine

Christin Carter-Su, Ph.D.

Professor, Department of Molecular and Integrative Physiology and Associate Director and Chief, Biomedical Research, Michigan Diabetes Research and Training Center

Steven Clark, Ph.D.

Associate Professor of Molecular, Cellular and Developmental Biology

Gyorgyi Csankovszki, Ph.D.

Assistant Professor of Molecular, Cellular and Developmental Biology

Robert Denver, Ph.D.

Professor of Molecular, Cellular and Developmental Biology, and Professor of Ecology and Evolutionary Biology

Andrzej Dlugosz, M.D.

Professor, Department of Dermatology

Gregory Dressler, Ph.D.

Professor, Department of Pathology; Co-Director, Center for Organogenesis

Cunming Duan, Ph.D.

Associate Professor, Department of Molecular, Cellular and Developmental Biology

James Douglas Engel, Ph.D.

G. Carl Huber Professor and Chair, Department of Cell and Developmental Biology; Co-Director, Center for Organogenesis

Eva Feldman, M.D., Ph.D.

Professor, Department of Neurology

Renny T. Franceschi, Ph.D.

Professor, Department of Periodontics and Oral Medicine, Dental School; Professor, Department of Biological Chemistry

Tom Glaser, M.D., Ph.D.

Associate Professor, Departments of Human Genetics and Internal Medicine

Steven Goldstein, Ph.D.

Henry Ruppenthal Family Professor of Orthopaedic Surgery and Bioengineering; Associate Chair for Research, Department of Orthopaedic Surgery; Professor, Mechanical Engineering; Professor, Biomedical Engineering; Research Professor, Institute of Gerontology

Deborah Gumucio, Ph.D.

Professor, Department of Cell and Developmental Biology; Director, Center for Organogenesis

Gary Hammer, M.D., Ph.D.

Millie Schembechler Professor of Adrenal Cancer, Department of Internal Medicine and Molecular and Integrative Physiology

Peter F. Hitchcock, Ph.D.

Professor, Departments of Ophthalmology and Visual Sciences and Cell and Developmental Biology

Lori Isom, Ph.D.

Professor of Pharmacology

Tom Kerppola, Ph.D.

Professor, Department of Biological Chemistry; Investigator, Howard Hughes Medical Institute

Paul H. Krebsbach, D.D.S., Ph.D.

Professor and Chair, Biologic & Materials Sciences; Roy H. Roberts Professor of Dentistry and Professor of Biomedical Engineering.

Peter X. Ma, Ph.D.

Professor, Departments of Biologic and Materials Sciences, Biomedical Engineering, Macromolecular Science and Engineering

Ormond A. MacDougald, Ph.D.

Associate Professor, Department of Molecular and Integrative Physiology

Benjamin Margolis, M.D.

Professor, Departments of Internal Medicine and Biological Chemistry

Donna M. Martin, M.D., Ph.D.

Assistant Professor Department of Pediatrics and Communicable Diseases and Assistant Professor of Human Genetics

Miriam Meisler, Ph.D.

Professor, Department of Human Genetics

Juanita Merchant, M.D., Ph.D.

Professor, Internal Medicine and Integrative and Molecular Physiology

Joseph Metzger, Ph.D.

Professor, Departments of Molecular and Integrative Physiology and Internal Medicine

Daniel Michele, Ph.D.

Assistant Professor, Molecular and Integrative Physiology and Internal Medicine

Sean J. Morrison, Ph.D.

Director, Center for Stem Cell Biology; Associate Research Investigator, Life Sciences Institute; Associate Professor, Internal Medicine, Division of Molecular Medicine and Genetics; Associate Professor, Cell and Developmental Biology; Investigator, Howard Hughes Medical Institute

K. Sue O'Shea, Ph.D.

Professor, Cell and Developmental Biology

Pamela Raymond, Ph.D.

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Diane M. Robins, Ph.D.

Professor, Department of Human Genetics; Research Scientist, Reproductive Sciences Program

Jessica Schwartz, Ph.D.

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Diane M. Simeone, M.D.

Professor, Department of Surgery and Molecular & Integrative Physiology

Daniel Teitelbaum, M.D.

Professor, Department of Surgery

Deneen Wellik, Ph.D.

Assistant Professor, Department of Internal Medicine, Division of Molecular Medicine & Genetics; Department of Cell and Developmental Biology

Yukiko Yamashita, Ph.D.

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