2024 Linda F. Hayward Florida Veterinary Scholars Program Faculty Application

Name	Chris Martyniuk
Email address	cmartyn@ufl.edu
Proposed project title	CRISPR gene targeting in canine fibroblast cells for pyruvate dehydrogenase kinase 4
Will you provide matching student stipend funding ($2500)?	Yes.
Source of project/research funding	Morris Animal Foundation

Prior student research mentees (last 5 years, if applicable):

CLASS	STUDENT	PROJECT TITLE	STATUS
2023	Sasha E Spada-O'Neill	CRISPR/Cas9 gene editing in canine cells for PDK4	Project ongoing, Manuscript in progress
2023	Arielle Admonius	Gene editing in cats	Project ongoing, Manuscript in progress
2022	Alexis Kidd	The effects of methimazole on cat thyroid cells	Project ongoing, Manuscript in progress
2022	Nirali Pathak	CRISPR/Cas9 gene editing in canine cells for Titin	Project ongoing, Manuscript in progress
2021	Alexandria Bergen	The effects of methimazole on cat thyroid cells	Project ongoing, Manuscript in progress
2021	Cristina Chinchayan	CRISPR/Cas9 gene editing in canine cells for Titin	Project ongoing, Manuscript in progress
2018	Maryle Triggs	CRISPR/Cas9 gene editing for LRRK2 in SH-SY5Y cells	Manuscript in progress
2017	Darby Toth	Primary epithelial culture for gut in hypertensive rats	Poster presentation at NIH/Manuscript pending
2016	Amy Hanlon	Evaluation of Microbiome-Host Relationships in the Zebrafish Gastrointestinal System Reveals Adaptive Immunity Is a Target of Bis(2-ethylhexyl) Phthalate (DEHP) Exposure	Poster presentations at NIH and Genetics Institute / Publication in Environ. Sci. Tech. IF = 7.9
2015	Kaylee Brown	The effects of pregnenolone on fathead minnow ovary	Posters at the genetics Institute; publication pending

2014	Denise Aleman	Liver slices	Poster presentation at Genetics Institute / publication pending

I agree to obtaining all necessary approvals (e.g. IACUC/IRB/EH&S/VHRRC – see below for specifics) to conduct the project with the student PRIOR to the commencement of the summer program, as well as submitting documentation of these approvals to the FVSP board by 5/20/24

YES

I agree to assisting my student prepare for the summer program during the Spring semester, which will include preparation of a study outline, and training in relevant laboratory techniques.

YES

I agree to plan for commencing the experiment/data collection by the beginning of the summer program (5/20/19)

YES

	Needed (Yes/No)	Approval by 5/20/22 (Yes/No)?
IACUC Approval and Training	Yes	Yes
IRB Registration and Training	No	
Biological Agent Registration	No	
Biopath Registration	No	
Veterinary Hospital Research	No	
FERPA Training	No	
Biohazardous Waste Training	No	
Laboratory Safety Training	Yes	Yes

Abstract of proposed student project.

Approximately 10% of all dogs in the United States have some form of heart disease which can progress to heart failure. In canines, DCM is the 3rd most frequent type of heart disease and is a significant health issue for many breeds. The Doberman Pinscher is affected by a specific form of DCM, inherited as an autosomal dominant trait with incomplete penetrance [1]. The prevalence of the disease in the DP is higher than that of other breeds, and ranges in incidence from 45 to 63% [2, 3]. Doberman Pinschers have a high mortality rate, with mean survival times less than 6 months following the first episode of congestive heart failure [4]. DCM in canines have been linked to two major genetic defects, including one gene called pyruvate dehydrogenase kinase 4 (PDK4). Doberman Pinscher can be genotyped for PDK4 to predict risk of heart disease. There are currently >300 DPs genotyped and phenotyped in Florida. Due to the degree of genetic heterogeneity in Doberman Pinscher, along with the high mortality rates, novel therapeutic strategies are urgently needed to treat DCM. New approaches in CRISPR gene editing show promise for treating cardiomyopathies. For example, homology- independent target integration (HITI) can be used to insert a corrected sequence into the homozygous (PDK4 del/del) cell, resulting in cells that exhibit wildtype phenotypes. We have optimized fibroblast cultures containing either the wildtype, heterozygous, or homozygous PDK4 mutation. The overarching goal of this large collaborative project is to design CRISPR gene editing tools to modify the PDK4 gene in Doberman Pinchers. This *student-led* project will develop and screen transfection strategies for CRISPR gene editing approaches in fibroblast cells. These investigations have broader implications for many other susceptible breeds that have increased risk of heart disease (e.g., Irish Wolfhounds, Great Danes, Boxers, and Bulldogs.

Specific Aim 1 Screen and test efficacy of sgRNA probes in fibroblast cells.

The objectives of the study will include the following: (1) Culture fibroblast from Doberman Pinschers that differ in genotype (2) Verify mutants with DNA sequencing and develop guide RNAs to target sites for gene editing of PDK4. The present study will contribute to the development of future CRISPR techniques to mitigate the prevalence of DCM in Doberman Pinschers.

Approach: We will aim to identify combinations of Cas9 enzymes and candidate sgRNA that target regions of interest for a one and two site HITI approach. One goal is to utilize an AAV vector for delivery in vivo, and we will also pursue smaller Cas9 enzymes including saCAS9, cjCAS9, and nme2Cas9, which have a more limited set of PAM sites than the extensively modified spCAS9. We will use several computational tools to identify candidate Cas9/sgRNA combinations for systematic evaluation. Candidate sgRNAs that target the PDK4 regions of interest will be matched with corresponding all-in-one AAV vectors. We will subsequently clone all sgRNAs into the corresponding vectors and sequence verify the clones. We will then test sgRNAs both in vitro and in vivo for targeting efficiency in both Doberman Pinscher fibroblasts and a new cell line recently obtained, A72 canine fibroblast cells. Cells will be transfected with each vector and CRISPR targeting efficiency assessed. To assess targeting efficiency, we will consider TIDER, which uses DNA sequencing around the corresponding targeted region and Sanger sequencing of the targeted region followed by analysis with ICE algorithm.

The significance for Veterinary Medicine and the student. CRISPR/Cas9 gene editing has emerged as a powerful approach to understanding the roles of genes in all animals and humans. The student will learn the basics of cell culture and how to conduct cell transfections. SYBR green gene expression assays will be conducted to quantify transcription levels in all three cell types. These assays will follow standard protocols optimized in the Martyniuk laboratory. We have developed a small project which has a testable hypothesis and one that will move our larger project forward. We currently have a resident (Dr. L Shen) developing CRISPR technologies and the veterinary student will interact significantly with our team and with Dr. Shen to learn about gene editing approaches in small animal medicine. Conducting both gene expression analysis and an enzyme activity is feasible within the 3-month internship and Dr. Martyniuk and his team will work closely with the student to ensure success. We encourage trainees to present their

research at the UF Genetics Institute symposium in the Fall. Students will develop their own posters and present to the wider UF community, representing our College in research on campus which is very important.

References:

1. Meurs KM, Fox PR, Norgard M, Spier AW, Lamb A, Koplitz SL, Baumwart RD. A prospective genetic evaluation of familial dilated cardiomyopathy in the Doberman pinscher. Journal of veterinary internal medicine. 2007;21(5):1016-20.
2. Hazlett M, Maxie M, Allen D, Wilcock B. A retrospective study of heart disease in Doberman Pinscher dogs. The Canadian Veterinary Journal. 1983;24(7):205.
3. O'grady M, Minors S, O'sullivan M, Horne R. Effect of pimobendan on case fatality rate in Doberman Pinschers with congestive heart failure caused by dilated cardiomyopathy. Journal of veterinary internal medicine. 2008;22(4):897-904.
4. Summerfield NJ, Boswood A, O'Grady MR, Gordon SG, Dukes-McEwan J, Oyama MA, Smith S, Patteson M, French AT, Culshaw GJ. Efficacy of pimobendan in the prevention of congestive heart failure or sudden death in Doberman Pinschers with preclinical dilated cardiomyopathy (the PROTECT Study). Journal of Veterinary Internal Medicine. 2012;26(6):1337-49.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Christopher J. Martyniuk

eRA COMMONS USER NAME (credential, e.g., agency login): CMARTYNI

POSITION TITLE: Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Simon Fraser University	BS	1991-96	Biology
Simon Fraser University	Post-Bacc	1996-98	Biochem/Mol. Biology
University of Guelph	MS	1998-01	Quantitative Genetics
University of Ottawa	PhD	2001-06	Physiology/Toxicology
University of Florida	PDF	2006-08	Molecular Toxicology

A. Personal Statement

My research program investigates the relationship between environmental chemical exposure and wildlife and human disease, with an emphasis on endocrine disruptors and reproduction. I use molecular based assays and computational methods to interrogate signaling pathways in animal models to determine mechanisms of endocrine disruption [1-4]. My primary role for this project will be to conduct mitochdrial bioenergetics assays to support computational analyses, and mentor graduate students in assays related to mitochondrial biology and toxicology. *I am a **New Investigator by the NIH,** and I have published +100 peer-reviewed manuscripts since 2019* **(career total: 305)**. Recent publications include Proc. Natl. Acad. Sci. USA, Sci. Rep., Environ. Sci. Technol., Frontiers Genetics, Environ. Pollut., and Acta Physiol. These publications include research in endocrine disruption (thyroid, estrogen, androgens), biomarker discovery (transcriptomic, miRNAs, lipidomics, proteomics) mitochondrial bioenergetics, and computational biology. I have the expertise required to conduct experiments in toxicology and to characterize molecular outcomes related to tributyltin. My research contributions have been acknowledged by two major societies, the Canadian Society of Zoology and the North American Society of Comparative Endocrinology (**New Investigator Award** on both a National and International Level). Only one award is given by each society. At the UF, I was a recipient of the **Zoetis Award for Research Excellence in Veterinary Medicine (2018)** and awarded a prestigious **UF Term Professor Award** bestowed to the top performing faculty at the University. My group was awarded the **Best Paper of the Year 2018** in Environ. Toxicol. Chem. (Adamovsky et al., 2018). I am the Editor-in-Chief for Comp. Biochem. and Physiol Part D: Genomics and Proteomics (Elsevier). I have directed projects funded by the NIH, USGS, Department of National Defense Canada, Natural Sciences and Engineering Council of Canada, and EU Horizon 2020 as well as industry partners. My leadership includes managing budgets, writing publications with my trainees, and mentorship (total: 5 PDF, 4 PhDs, 8 MS, and ~50 undergraduate students).

Ongoing add recently completed projects that I would like to highlight include:

Department of Defense (Co-PI) 1/1/2023-12/31/2027
ER22-C1-3095 Complex-mixture uptake and integrated organismal effects. This grant will study the effects of perfluorinated chemicals in fathead minnow and zebrafish.

National Institutes of Health NIEHS (PI Martyniuk) 09/01/21-08/31/23
Examining thyroid hormone synthesis feedback loops as xenobiotic target for brominated flame-retardant metabolites. The overall goal is to study the role of thyroid hormone receptor beta2 in mediating the effects of brominated diphenyl ethers in the human hypothalamus.

Morris Animal Foundation (PI Martyniuk) 09/01/21-12/31/23
CRISPR/Cas9 homology-independent targeted insertion (HITI) strategy to advance gene therapy in canine iPSC-derived cardiomyocytes. The overall goal is to develop a HITI gene editing approach to correct cardiomyocytes of Dobermans deficient in PDK4.

Royal Canin USA, Inc. (AGR00015231) 05/01/20-04/30/22
Development of a feline hyperthyroid cell line. The overall goal is to develop a feline thyrocyrte cell line to test the effects of supplements on thyroid hormone production in vitro.

National Institutes of Health R21 09/01/18-11/30/21
NATL CTR FOR COMPLEM AND INTEGRATIVE HLT (PIs Martyniuk, Zubcevic) R21AT010192
Gut-brain axis: functional link between microbial metabolites and neurogenic hypertension
The overall goal is to identify gut metabolites in neurogenic hypertension mammalian models that regulate blood pressure. These metabolites are hypothesized to be therapeutic agents for the disease.

Citations:

1. Huang T, Zhao Y, He J, Cheng H, Martyniuk CJ. 2022. Endocrine disruption by azole fungicides in fish: A review of the evidence. Sci Total Environ. 822:153412.
2. Dos Santos B, Ivantsova E, Guzman AP, Martyniuk CJ. 2022. Critical review of the toxicity mechanisms of bisphenol F in zebrafish (*Danio rerio*): Knowledge gaps and future directions. Chemosphere. 297:134132.
3. Huang T, Jiang H, Zhao Y, He J, Cheng H, Martyniuk CJ. 2022. A comprehensive review of 1,2,4-triazole fungicide toxicity in zebrafish (*Danio rerio*): A mitochondrial and metabolic perspective. Sci Total Environ. 809:151177.
4. Martyniuk CJ, Feswick A, Munkittrick KR, Dreier DA, Denslow ND. 2020. Twenty years of transcriptomics, 17alpha-ethinylestradiol, and fish. Gen Comp Endocrinol. 286:11332510.

B. Positions and Honors

2008-2009	**Research Assistant Professor** Center for Environmental and Human Toxicology, University of Florida
2009-2013	**Assistant Professor & Tier II Canada Research Chair** Department of Biology, University of New Brunswick
2013-2014	**Associate Professor & Tier II Canada Research Chair** Department of Biology, University of New Brunswick
2014-current	**Associate Professor** Center for Environmental and Human Toxicology, University of Florida
2020-current	**Associate Professor with Tenure** Center for Environmental and Human Toxicology, University of Florida
2021-current	**Associate Chair, Department of Physiological Sciences** Center for Environmental and Human Toxicology, University of Florida

Honors and Awards (post-graduate awards only)

2009-13	**Canada Research Chair** Tier II in Molecular Ecology (UNB), awarded to emerging international leaders in their field of research.
2013	**The Gorbman-Bern New Independent Investigator Award** for *the top North American New Investigator in Endocrinology* (North American Society for Comparative Endocrinology).
2013	**Bob Boutilier New Investigator Award** given to the *top New Investigator in Canada in Zoology* (Canadian Society of Zoology)
2016	Award for most highly cited paper in Comparative Biochemistry and Physiology - Part D:

Genomics and Proteomics (Ornostay et al. 2013)
Nomination for Best Paper Award to the most outstanding paper published in 2017 in Environmental Toxicology and Chemistry (Feswick et al. 2017) – 10 nominations.

2018 Zoetis Award for Research Excellence in Veterinary Medicine

2021-23 **University of Florida Term Professor for Research**

Professional Memberships: Society of Toxicology (2008-09, 2016-current), North American (NA)/European Society of Environmental Toxicology Chemistry (2006-17), Canadian Society of Zoology (2008-13), NA Society for Comparative Endocrinology (2010-17).

Editorial Services

(1) **Editor-in-Chief** for Comparative Biochemistry and Physiology: Part D Genomics and Proteomics
(2) **Associate Editor**: Frontiers in Genetics (2018)
(3) Elected Councillor to the North American Society for Comparative Endocrinology (2020-2023)
(4) Ad hoc reviewer for ~160 scientific articles, spanning 38 journals, panel member for the National Science Foundation, Ad hoc reviewer for NIH (four times on training and program grant panel reviews), NSF, Natural Sciences and Engineering Council of Canada, and Environmental Protection Agency
(5) Editorial Board of Frontiers in Experimental Endocrinology (2011-current)
(6) Environmental Toxicology and Chemistry (editor for OMICS and Environmental Science) (2011)

International Symposium Chair / Scientific Committees/Expert Panel (selected from 21 sessions as chairs)

2019/2021 In 2019 and 2021, I Chaired the Local Organizing Committee of the 5th and 6th Biennial North American Society for Comparative Endocrinology. I oversaw both international conferences, hosting delegates from around the world (170-180 members).

2020 Session Chair: Adverse effects of chemicals on the microbiome. Setac North America 41st annual meeting 15 to 19 November 2020 Fort Worth Texas USA. Co-Chairs Bisesi J, Martyniuk CJ, Griffitt J, Wormington A.

2019 Session Chair: Advancing Omics into Regulatory Frameworks: Case studies and perspectives. SETAC North America 40th Annual Meeting, Nov. 3-7th, Toronto, ONT, CAN Co-chairs Biales A, Martyniuk CJ, Zupunic A.

2018 Session Chair: Advancing the adverse outcome pathway concept for mitochondrial dysfunction. SETAC North America 39th Annual Meeting, Nov. 4-8th, Sacramento, CA. USA. Co-Chairs: J. Meyer. D. Dreier, D Melo

C. Contribution to Science

I have divided my significant achievements into the areas of expertise needed to successfully execute and complete this proposed research. *Manuscripts are selected from 280.* **The link to my bibliography is:** https://www.ncbi.nlm.nih.gov/myncbi/christopher.martyniuk.1/bibliography/public/

(1) Toxicology and reproduction: Under a previously awarded University of Florida Superfund Program Grant, I was tasked as a PDF with identifying the molecular mechanisms underlying reproductive impairment in largemouth bass. Through the research, we identified key cell signaling pathways associated with reproductive processes along the hypothalamic-pituitary-gonadal axis, many of which fell under the theme of the metabolism [5-8]. I continue to study *reproduction and endocrine disruptors of fertility and reproductive success*. **The significant impact on science** is that we now more clearly understand mechanisms related to pesticide-induced dysfunction on metabolism and reproduction from chemical exposure. My role was to collaborate with graduate students, conduct experiments, interpret results, and contribute to the writing of the manuscripts.

5. Martyniuk CJ, Mehinto AC, Denslow ND. 2020. Organochlorine pesticides: Agrochemicals with potent endocrine-disrupting properties in fish. Mol Cell Endocrinol. 507:110764.

6. Martyniuk CJ, Mehinto AC, Colli-Dula RC, Kroll KJ, Doperalski NJ, Barber DS, Denslow ND. 2020. Transcriptome and physiological effects of toxaphene on the liver-gonad reproductive axis in male and female largemouth bass (*Micropterus salmoides*). Comp. Biochem. Physiol. Part D Genomics Proteomics 36:100746.

7. Martyniuk CJ, Doperalski NJ, Feswick A, Prucha MS, Kroll KJ, Barber DS, Denslow ND. 2016. Transcriptional networks associated with the immune system are disrupted by organochlorine pesticides in largemouth bass (*Micropterus salmoides*) ovary. Aquat Toxicol. 177:405-16.
8. Martyniuk CJ, Doperalski NJ, Prucha MS, Zhang JL, Kroll KJ, Conrow R, Barber DS, Denslow ND. 2016. High contaminant loads in Lake Apopka's riparian wetland disrupt gene networks involved in reproduction and immune function in largemouth bass. Comp. Biochem. Physiol. Part D Genomics Proteomics. 19:140-150.

***(2)* Lipids as targets for environmental chemicals.** We have recently investigated the relationship between environmental factors (i.e. temperature) and lipid profiles in fish [9]. Such data are expected to contribute to refined toxicity testing of environmental contaminants in small fish models such as zebrafish. In addition, our previous studies have revealed that lipids are significantly altered by organochlorine pesticides in fish tissues, and we outlined these data in our proposed research plan. We draw attention to lipid biosynthesis and metabolism as a significant target for emerging contaminants, such as the perfluorinated compounds in aquatic species and those *chemicals that act through PPAR signaling* [10]. We have also recently conducted untargeted lipidomics in cell lines to elucidate chemical induced toxicity [11]. **The significant impact on science** is the identification and characterization of lipid biomarkers for chemical exposures. The overarching goal of my laboratory's current research is to evaluate the role of lipids as key events in adverse outcome pathways for reproductive impairment and disrupted metabolism in aquatic species.

9. Dreier DA, Nouri MZ, Denslow ND, Martyniuk CJ. 2020. Lipidomics reveals multiple stressor effects (temperature × mitochondrial toxicant) in the zebrafish embryo toxicity test. Chemosphere 264(Pt 1):128472.
10. Dreier DA, Bowden JA, Aristizabal-Henao JJ, Denslow ND, Martyniuk CJ. 2020. Ecotoxico-lipidomics: An emerging concept to understand chemical-metabolic relationships in comparative fish models. Comp Biochem Physiol Part D Genomics Proteomics. 36:100742.
11. Sanchez CL, Souders CL 2nd, Pena-Delgado CJ, Nguyen KT, Kroyter N, Ahmadie NE, Aristizabal-Henao JJ, Bowden JA, Martyniuk CJ. 2020. Neurotoxicity assessment of triazole fungicides on mitochondrial oxidative respiration and lipids in differentiated human SH-SY5Y neuroblastoma cells. Neurotoxicology. 80:76-86.

(3) Mitochondrial bioenergetics profiling: Our group has optimized a high throughput mitochondrial bioenergetics assays for cells, tissues, and whole embryos. *Dysfunction in mitochondrial bioenergetics is one of the hallmarks for disease*, and can be related to reproductive and metabolic disturbances. Our studies have examined the response of embryos following chemical exposures [12-15]. We have used the zebrafish model, a prominent model for human disease, to investigate how pesticides affect bioenergetics in whole intact animals [14, 15]. **The significant impact on science** has been a deeper understanding of how mitochondrial bioenergetics is perturbed in whole tissues or developing fish. This high throughput bioassay for bioenergetics allows for the evaluation of multiple endpoints associated with ATP production, for example spare capacity of mitochondria, as well as maximum, non-mitochondrial, and basal respiration. My role on these projects was to oversee graduate students, conduct experiments, interpret results, and contribute to or write the manuscripts.

12. Souders CL 2nd, Liang X, Wang X, Ector N, Zhao YH, Martyniuk CJ. 2018. High-throughput assessment of oxidative respiration in fish embryos: Advancing adverse outcome pathways for mitochondrial dysfunction. Aquat. Toxicol. 199:162-173.
13. Bolser DG, Dreier DA, Li E, Kroll KJ, Martyniuk CJ, Denslow ND. 2018. Toward an adverse outcome pathway for impaired growth: Mitochondrial dysfunction impairs growth in early life stages of the fathead minnow (*Pimephales promelas*). Comp. Biochem. Physiol. C Toxicol. Pharmacol. 209:46-53.
14. Dreier DA, Mello DF, Meyer JN, Martyniuk CJ. 2019. Linking Mitochondrial Dysfunction to Organismal and Population Health in the Context of Environmental Pollutants: Progress and Considerations for Mitochondrial Adverse Outcome Pathways. Environ. Toxicol. Chem. 38(8):1625-1634.
15. Wang XH, Souders CL 2nd, Xavier P, Li XY, Yan B, Martyniuk CJ. 2020. The pyrethroid esfenvalerate induces hypoactivity and decreases dopamine transporter expression in embryonic/larval zebrafish (*Danio rerio*). Chemosphere. 243:125416.

(4) Network analysis and biomarker discovery. Bioinformatics is essential for large scale data integration and biomarker discovery. Bioinformatics methods have, in fact, been a significant bottleneck for molecular physiology and disease analysis and requires specialized training. **My research team has advanced computational**

approaches for the study of chemicals and disease. We have used interaction network analyses for omics datasets to characterize traumatic brain injury in rats [16] and ovarian cancer [17]. Our recent review highlights the importance of considering sex in proteomics experiments [18], suggesting that less than 25% of the proteome is conserved in response following chemical exposures between sexes. Lastly, our manuscript on gut microbiota and transcriptional networks in the gut **was highlighted by both Newsweek and The Washington Post** [19]. **The significant impact on science** includes new understanding as to the molecular networks that underlie human disease. My role was to oversee graduate students, conduct experiments, interpret results, and contribute to or write the manuscripts.

16. Zhang J, Knight R, Wang Y, Sawyer TW, Martyniuk CJ, Langlois VS. 2018. Comprehensive assessment of shockwave intensity: Transcriptomic biomarker discovery for primary blast-induced mild traumatic brain injury using the mammalian hair follicle. Brain Inj. 32(1):123-134.

17. Paullin T, Powell C, Menzie C, Hill R, Cheng F, Martyniuk CJ, Westerheide SD. Spheroid growth in ovarian cancer alters transcriptome responses for stress pathways and epigenetic responses. PLoS One. 12(8):e0182930.

18. Liang X, Feswick A, Simmons D, Martyniuk CJ. 2018. Environmental toxicology and omics: A question of sex. J Proteomics. 172:152-164.

19. Yang T, Ahmari N, Schmidt JT, Redler T, Arocha R, Pacholec K, Magee KL, Malphurs W, Owen JL, Krane GA, Li E, Wang GP, Vickroy TW, Raizada MK, Martyniuk CJ, Zubcevic J. 2017. Shifts in the Gut Microbiota Composition Due to Depleted Bone Marrow Beta Adrenergic Signaling Are Associated with Suppressed Inflammatory Transcriptional Networks in the Mouse Colon. Front Physiol. 8:220.

The link to my bibliography is:
https://www.ncbi.nlm.nih.gov/myncbi/christopher.martyniuk.2/bibliography/public/