Print Reset

Artistic and Scholarly Development (ASD) Grant Application

Name(s) Tyler Schwend

Department(s) or School(s) Biology

Title of Project Show and Tell: Publishing a Video Methods Article on Corneal Wound Healing and Regeneration

Amount Requested $2475 **Your Email:** tschwend@iwu.edu

- If your proposal is funded, would you be willing for the Mellon Center to use it as an exemplary submission in the online Handbook? ☑ Yes ☐ No

- Will you use human beings as experimental subjects? ☐ Yes ☑ No
  If yes, please submit the appropriate approval notice.
  If you have questions about whether IRB approval or exemption is required for your project, please see the pdf link on "Policies and Procedures" at https://www.iwu.edu/irb/forms/IRB_PolicyProcedure.pdf.

- Will you use animals as experimental subjects? ☑ Yes ☐ No
  If so, have you requested IRB and/or IACUC approval? ☑ Yes ☐ No
  If yes, please submit the appropriate approval notice.
  (See the IACUC link to protocol forms at https://www.iwu.edu/associateprovost)

Please complete the following checklist by placing a check mark against each item to insure that your application is complete. Incomplete and/or late applications will not be considered.

1. Project Summary included in hard copy of proposal and Word copy (emailed to chorner@iwu.edu) ☑ Yes ☐ No
2. Proposal as per format described in Handbook ☑ Yes ☐ No
3. ASD grant budget page ☑ Yes ☐ No
4. A Brief Vita ☑ Yes ☐ No
5. Reports for previous ASD grants have been filed separately with the Mellon Center ☑ Yes ☐ No ☐ NA

Robert Schwend 10/11/21
Signature of applicant and date

Steve Wall
Signature of chair or direct supervisor

Please note that a recommendation letter from a direct supervisor or chair is not required for ASD grants.

Artistic and Scholarly Development Proposal for Tyler Schwend

Project Title: Show and Tell: Publishing a Video Methods Article on Corneal Wound Healing and Regeneration

1. Cover Page (attached)

2. Project Summary:

The cornea is a dome-shaped, transparent tissue that focuses light as it enters the eye. The cornea is full of sensory nerve endings that are critical for normal cornea function. Damage to corneal tissue and its nerves is common following eye injury. Wounded corneas form opaque scar tissue that occludes the passage of light, thus distorting vision, while damaged corneal nerves regenerate slowly, leading to poor cornea health. There is a clear need to develop reliable animal models to address how corneal wound healing and nerve regeneration may be improved following injury. Recently, my collaborators and I established a corneal wounding technique in the embryonic chick enabling us to study aspects of corneal wound repair and nerve regeneration. I have been invited by the science journal JoVE to "show and tell" how the technique is conducted in a methods article. This proposal seeks funds to cover publication costs and tools.

3. Previous ASD Grants Awarded:

In 2019-2020 I was awarded an ASD titled "Location, Location, Location – The Importance of Locating Genes during Body Formation" to purchase reagents and research equipment that has enabled my laboratory to begin carrying out an important research technique known as *in situ* hybridization. In my field of embryology, nearly every publication utilizes this technique to determine when and where genes are located. While the technique had been regularly performed by another IWU faculty (Brian Walter, also an embryologist) in the past, our stock of reagents and available equipment are expired and outdated, respectively. This grant enabled me to replenish reagents and buy modern equipment. Because of COVID which required me to work from home, I deferred using the ASD funds to purchase reagents which have a shelf-life of 3-5 years. Upon my full-time return to campus in Summer 2021, all equipment and reagents were purchased and I am currently using the technique with the expectation that nearly all of my future research presentations and publications will contain data obtained using *in situ* hybridization. Thus, there is not a single end product. Rather, my entire research agenda was significantly elevated due to these funds being made available and I plan to update the FDC each time the technique made available through the funds is used in talks/grants/publications. Finally, because the funds were just recently awarded (June/July 2021), I arranged with Kevin Sullivan to have my ASD progress report delayed to November 2022 and thus have yet to submit it.

4. Narrative:

A. End product

Based on my scientific research background in eye development and regeneration, I have been invited by the editors of JoVE, a science journal that publishes video articles describing important scientific techniques, to contribute an article for a special methods collection edition

that JoVE is compiling entitled *Methods for Generating Corneal Wound Healing Models.* ASD funds are being sought to cover scientific tools and publication costs required to publish the scientific journal article, which will be the end product.

B. *Scholarly Significance of the Project*

Nature of problem to be examined:

We all have them and nearly all come with a story. On the hands of a welder they represent a life of hard work. While on an athlete's knee they represent a painful, lost season and a long, tedious recovery. No matter how they are acquired, our scars are visible markings that show off the cuts, scrapes and bruises we accumulate during our life.

While scars on our skin and internal organs are mostly harmless, a scar that forms on the outer-most layer of the eye, the cornea, can have devastating impacts to vision. The cornea is a transparent, window-like tissue that protects the eye by keeping harmful debris from entering the eye while its 'see-through' nature allows visual stimuli (light) to enter. Any reductions to the cornea's transparency results in less light entering the eye and a subsequent loss of vision. Eye diseases or surgeries that damage corneal tissue lead to opaque scar tissue that occludes the passage of light, thus permanently reducing the cornea's transparency. Importantly, over ten million people worldwide suffer from corneal blindness stemming from corneal wound healing and scar formation[1,2]. Thus, there is a clear and pressing need for eye researchers to develop good, reliable animal model systems for studying corneal wound healing and scarring.

Given that animal models to study corneal wound healing may support research to help understand how scars form and to test ways to mitigate or fully prevent corneal scar tissue formation, the editors at the Journal of Visualized Experiments (JoVE) have recently partnered with guest editor Dr. Yiqin Du, a leading vision researcher from the University of Pittsburgh, to compile a collection of methods articles focusing on novel ways to generate corneal wound animal models. Based on my long-standing research interests in corneal development and regeneration, I was invited by JoVE to contribute an article on the topic. My article will provide detailed methods, along with an accompanying video protocol, to "show off" how my laboratory generates corneal wounds in the embryonic chicken and then detail how we and others have used the wounded chicken corneas to study the wound healing process.

What makes the embryonic chick species such an attractive and important model for studying corneal wound healing is that, like most embryonic and fetal tissues, the wounded embryonic cornea can rapidly regenerate with no detectable scar tissue formation. This is in stark contrast to wounded adult corneas, where scarring invariably occurs. This means there is something inherently different between the embryo and the adult cornea, whereas the embryonic cornea is privileged and through some, as-of-yet unknown, mechanism(s) it can heal itself without a loss to transparency. I am excited to contribute my knowledge on generating wounds in embryonic corneal tissue. My contribution, which I am hoping will be funded by this ASD, will help other talented researchers at institutions around the world to begin using the embryonic chick as a model organism to address questions of corneal wound healing and to help better understand how the process occurs scar-free in the embryonic chick model system.

Scholarly Context:

My research focuses on eye development and regeneration. My interest in corneal wound healing and scar formation stems from a larger question that drives nearly all of my research – that is, how can we improve patient comfort and shorten recovery time following elective,

corrective cornea surgeries, such as LASIK or cornea transplantation? While these corrective surgeries are very successful for improving vision, oftentimes they are associated with eye pain and nagging dry eye lasting for months or even years. The discomfort and dryness that patients experience post-surgery is caused by damage to sensory nerves in the cornea. Corneal sensory nerves, which bring about sensations of touch, pain and temperature, also play vital roles in the blink reflex and tear production[3]. Following damage, regeneration of corneal nerves occurs slowly, and is often incomplete. Until these nerves fully regenerate, the patient experiences dry eye disease due to reduced tear production, as well as pain, which is commonly associated with loss of nerve integrity[4,5]. The restoration of nerve function in the cornea following damage represents a significant clinical challenge in the field of ophthalmology.

In order to address this therapeutic need, my laboratory uses the embryonic chick as an experimental paradigm for cornea regeneration. My past studies showed that acquisition of nerves by embryonic corneas is well-coordinated, but occurs slowly over the course of many days[6,7]. My current research exploits the slow growth of nerves through the developing cornea, asking whether we can experimentally coax the nerves to grow faster. If so, presumably the same experimental approach can be extended to the regenerating cornea in patients experiencing slow nerve growth recovery following corrective surgeries.

Our approach to hasten nerve growths is pharmaceutical. We test molecules that are believed to promote nerve growth by administering the molecule to the developing chick and examining whether acquisition of nerves by the cornea is hastened. This approach has proven successful. Recently, my laboratory completed a study which described how raising the levels of thyroid hormone in the chick embryo, by administering it exogenously to the chick, could dramatically accelerate the rate of growth of nerves into the cornea (Appendix, Figure 1)[8]. This work, involving six IWU undergrads, has implicated thyroid hormone as a potential therapeutic to promote functional nerve recovery following corneal surgeries.

Of course, once a compound like thyroid hormone is shown to speed up nerve growth during development, the next query is to determine whether the nerve-enhancing benefits extend to the more clinically applicable situation of growth through a damaged, regenerating cornea. To address this, I had to learn how to wound corneas. Luckily, my closest research collaborator, Dr. Peter Lwigale and his students at Rice University had developed a corneal wounding technique in the embryonic chick. His lab's work led to our understanding that embryonic corneas heal scar-free[9,10]. In 2018, using money earned through an Illinois Wesleyan Grants Competition hosted jointly through the Provost and Grants office, I traveled to Peter's lab in Houston, Texas and learned the technique first-hand. Since then, I have used the technique regularly to address questions related to nerve regeneration in wounded corneas, such as testing the efficacy of thyroid hormone on the nerve recovery process.

To my knowledge, only two laboratories in the world (mine and Peter's lab at Rice) have been using the corneal wounding technique, with his lab focused on how the corneal tissue regenerates scar-free and mine on how nerves respond to the damaged, healing tissue. For that reason, both of our labs were contacted by JoVE to contribute a video methods article. I plan to collaborate on the project with Peter, with my lab leading the endeavor and myself as the lead and corresponding author.

Methodology:

JoVE's model for teaching scientific techniques models how one might learn how to cook a new recipe. Imagine you want to made a pumpkin pie. You have two options. Open up a

cookbook and read the steps or find a website that provides the same helpful written steps but is accompanied with a short video that will allow you to see and hear the preparatory and baking steps. The latter approach, utilized by JoVE appeals to multiple learning modalities and has become the premiere way that scientific methods are shared in my field.

JoVE articles combine a written text manuscript, detailing the steps involved in the protocol and a brief description of how the technique can be used and for what types of research questions, as well as a video that shows off how to the experimental procedure. I have finalized the details of the publication process with JoVE editors which are provided in the timeline below.

Given that we are a teaching institution, I decided to highlight a student doing the technique for the video. Manish Pathuri '22 is my most experienced research student. He has worked with me consistently since the Spring of his freshman year, including full-time over two summers (State Farm fellowship and Criley fellowship). Manish and I plan to work weekly on the technique, ensuring that he masters it. The technique is technically very challenging and involves multiple steps lasting the course of a week. Briefly, fertilized eggs are obtained from a poultry farm in Urbana, IL. These eggs are brought to my lab where they are put in an egg incubator which enables their development to occur.

The wounding incision step, which prompts the cornea regeneration activities that we and others are trying to study, is straight-forward. The challenge is gaining access to the developing cornea, given that it is tightly tucked away inside of an egg. When we first put the eggs in the incubator, they are mostly yolk and albumen (egg white), with only a few cells floating on the yolk. For those few cells to successfully give rise to many cells that will go on to generate organs and take the final form of the chicken, the cells need to be nourished. The nourishment comes from proteins and nutrients, deposited into the yolk and albumen of the egg by the mother hen, and oxygen from the outside environment that diffuses into the egg through tiny micropores. To access the nutrition and oxygen, a complex network of membranes and blood vessels are set up around the developing embryo. These blood vessels act like the mammalian placenta, bringing oxygen and nutrients from the egg contents into the embryo. Considering this, in order to access the cornea one must break into the eggshell, get through the albumen/yolk and past the blood vessels which tend to engulf and surround the embryo at the stage we want to wound it.

This can be accomplished by making a small hole in the egg. Through the hole we extract a portion of the albumen. This enables us to make a small window in the top of the eggshell without albumen leaking out everywhere. The small window, which we make two days into development, allows us to gain access to the embryo as it develops in the egg. Shortly thereafter, the extraembryonic membranes begin to form over the embryo. Using sharp jeweler's forceps brought into the eggshell through the window, we carefully pull back the membranes so that they don't cover the embryo. This step must be carried out on a daily basis to ensure the membranes don't re-grow over the embryo. It also must be done very carefully using a microscope because the membranes contain many blood vessels and nicking even one blood vessel will kill the embryo. Following daily microsurgery of the extra-embryonic membranes, from the fifth day through the seventh day of development, one can access the eye and wound it by carefully making an incision. Our video, led by Manish, will show off the tools, reagents and microscopy equipment that are needed for the procedure and detail how each step is performed.

C. Professional Significance of the Project

This project has four clear benefits to my scholarly activities, while also potentially having a big impact on researchers in my field that will be able to learn the technique. First, this publication will help establish my laboratory as one that can make important contributions to the field of corneal wound healing and scar-free corneal regeneration. Though I have used the corneal wound healing technique in my laboratory, I have yet to publish an article using the procedure. Thus, this publication will provide wider visibility to my laboratory as a leader in corneal wound healing in the embryonic chick. As corresponding author, I expect to hear from many researchers seeking both my help with the technique and also those interested in collaborating on the technique.

Second, publication of the methods article will provide credibility to my future grant applications, particularly those seeking funds to study corneal wound healing and regeneration. I have multiple, open research questions that require the corneal wound healing model in the embryonic chick. Addressing these questions well may likely require me securing external funding. My grant applications will be significantly elevated in the minds of grant reviewers because they will have confidence that my laboratory can successfully conduct the technique. Beyond my question related to the effectiveness of thyroid hormone to hasten nerve regeneration (described above), I am also interested in studying the direct effect that nerves may have on the scar-free cornea regeneration process. It was recently shown that corneal nerves release small neuropeptides that provide a range of regenerative potential to the eye during development[11]. Recent efforts in my laboratory have aimed at using the corneal wound healing model to address whether corneal nerve-derived neuropeptides possess similar regenerative potential to the corneal tissues. I look forward to referencing the corneal wound healing methods article in future grant applications seeking to address these questions.

The third benefit will be to my own ability to carry out the technique successfully. As Yogi Bhajan famously said, "If you want to master something, teach it." To date, I have spent dozens of hours practicing the technique and have taught it successfully to three of my past research students. However, our results have been inconsistent and not publication worthy. Knowing that my student and I will need to teach others to do the technique, I will have the motivation to truly "master" the technique. This opportunity will truly elevate my ability to do the technique which should enable my students and I to have more consistent success and achieve reproducible, publication-worthy results.

The fourth benefit is that the methods article can be shared with all of my current students and future ones hoping to learn the technique. This will make it quicker and easier for students helping me to carry out my research agenda to learn how to wound corneas and study corneal regeneration.

D. Proposed expenses

I am requesting $2475, of which:

- ~$1400 will go to cover JoVE publication fees (see Appendix for email communication from JoVE stating the publication fees),
- $600 will go to stipend (the maximum amount allowable for publication fees/stipend is stated to be $2000) and
- ~$475 will be needed to cover the costs of scientific tools (listed below).

Scientific tools
The following reagents are required. I am seeking two pairs of forceps, one pair for me and one for my student. These are necessary to dissect away the extra-embryonic membranes from the eye. I am also seeking a new micro-dissecting knife for making the corneal incision. New tools will be necessary to carry out the technique well and we need to have high quality tools for the video. The eggs, syringes and needles are also needed to perform the technique.

3 dozen fertilized eggs (from University of Illinois poultry)	$30.00
5 ml syringes (pack of 100 from ThermoScientific)	$20.00
#18 gauge needles (pack of 100 from ThermoScientific)	$20.00
#5 Dumont forceps (Biology Dumostart – Fine Sci. Tools) – 4 total	$260.00
30° Angled Micro-dissecting knife (Fine. Sci. Tools)	$143.00

E. Proposed timetable

October 2021 – January 2022	Prepare and submit the written manuscript. Due date is November 8th, 2021. Manuscript goes through peer review which typically takes 2-3 months (according to the JoVE editor)
February 2022 – April 2022	PhD level scientists at JoVE prepare a script for the video portion of the publication. I approve the script.
April – May 2022	I will train Manish Pathuri '22 to carry out the technique and work with him to learn the script from JoVE.
May 2022	A trained videographer from JoVE will come to Illinois Wesleyan to record Manish (and myself) conducting and explaining the procedure, according to the script. **For the video, reagents requested in this ASD will be used.**
May – June 2022	Unedited footage goes to JoVE headquarters and post-production team for editing
June – July 2022	Video is approved and is published online with the previously approved, peer-reviewed written manuscript. **Publishing fees are due.**

F. Student Assistants
N/A - My students receive course credit and are not paid.

G. IACUC Review
Use of chick embryos in my research laboratory is carried out under the active IACUC protocol Protocol 19-009 and will not expire until September 16th, 2022. The proposed work in this ASD project will be completed prior to the expiration date. I have included the IACUC approval letter in the application materials.

References

[1]Pascolini D, Mariotti SP, Pokharel GP, Pararajasegaram R, Etya'ale D, Negrel AD, Resnikoff S. 2002 global update of available data on visual impairment: a compilation of population-based prevalence studies. *Ophthalmic. Epidemiology*. 2004;11(2):67-115.

[2]Whitcher JP, Srinivasan M, Upadhyay MP. Corneal Blindness: a global perspective. *Bull World Health Organization*. 2001;79(3):214-21.

[3] Belmonte C, Aracil A, Acosta MC, Luna C, Gallar J. Nerves and sensations from the eye surface. *The Ocular Surface*. 2004;2(4):248-253.

[4] Lee HK, Lee SJ, Kim EK, Kim JK, Seo KY. Comparison of corneal nerve regeneration and sensitivity between LASIK and laser epithelial keratomileusis (LASEK). *American Journal of Ophthalmology*. 2006;141(6):1015.e1.

[5] Patel SV, McLaren JW, Kittleson KM, Bourne WM. Subbasal nerve density and corneal sensitivity after laser in situ keratomileusis: Femtosecond laser vs mechanical microkeratome. *Archives of Ophthalmology*. 2010;128(11):1413-1419.

[6] Schwend T, Lwigale PY, Conrad GW. Nerve repulsion by the lens and cornea during cornea innervation is dependent on Robo–Slit signaling and diminishes with neuron age. *Developmental Biology*. 2012;363(1):115-127.

[7] Schwend T, Deaton RJ, Zhang Y, Caterson B, and Conrad GW. Corneal Sulfated Glycosaminoglycans and their Effects on Trigeminal Nerve Growth Cone Behavior *In Vitro*: Roles for ECM in Cornea Innervation. *Invest. Ophthalmol. Vis. Sci.* 2012;53(13):8118-8137.

[8]Patel M., Pham N, Ziegenhorn E, Deaton RJ, Pisano A, Kim S, Rajarathnam V, Schwend T. Unique and Overlapping Effects of Triiodothyronine (T3) and Thyroxine (T4) on Sensory Innervation of the Chick Cornea. *Experimental Eye Research.* 2020;194:108007.

[9] Spurlin J 3, James W, Lwigale PY. Wounded embryonic corneas exhibit nonfibrotic regeneration and complete innervation. *Investigative ophthalmology & visual science*. 2013;54(9):6334.

[10]Koudouna E, Spurlin J, Babushkina A, Quantock A, Jester J, Lwigale PY. Recapitulation of normal collagen architecture in embryonic wounded corneas. *Sci. Reports.* 2020; 10(1):13815.

[11] Perry KJ, Hamilton PW, Sonam S, Singh R, Henry JJ. The role of sensory innervation in cornea-lens regeneration. *Dev Dyn.* 2019;248(7):530-544.

Appendix

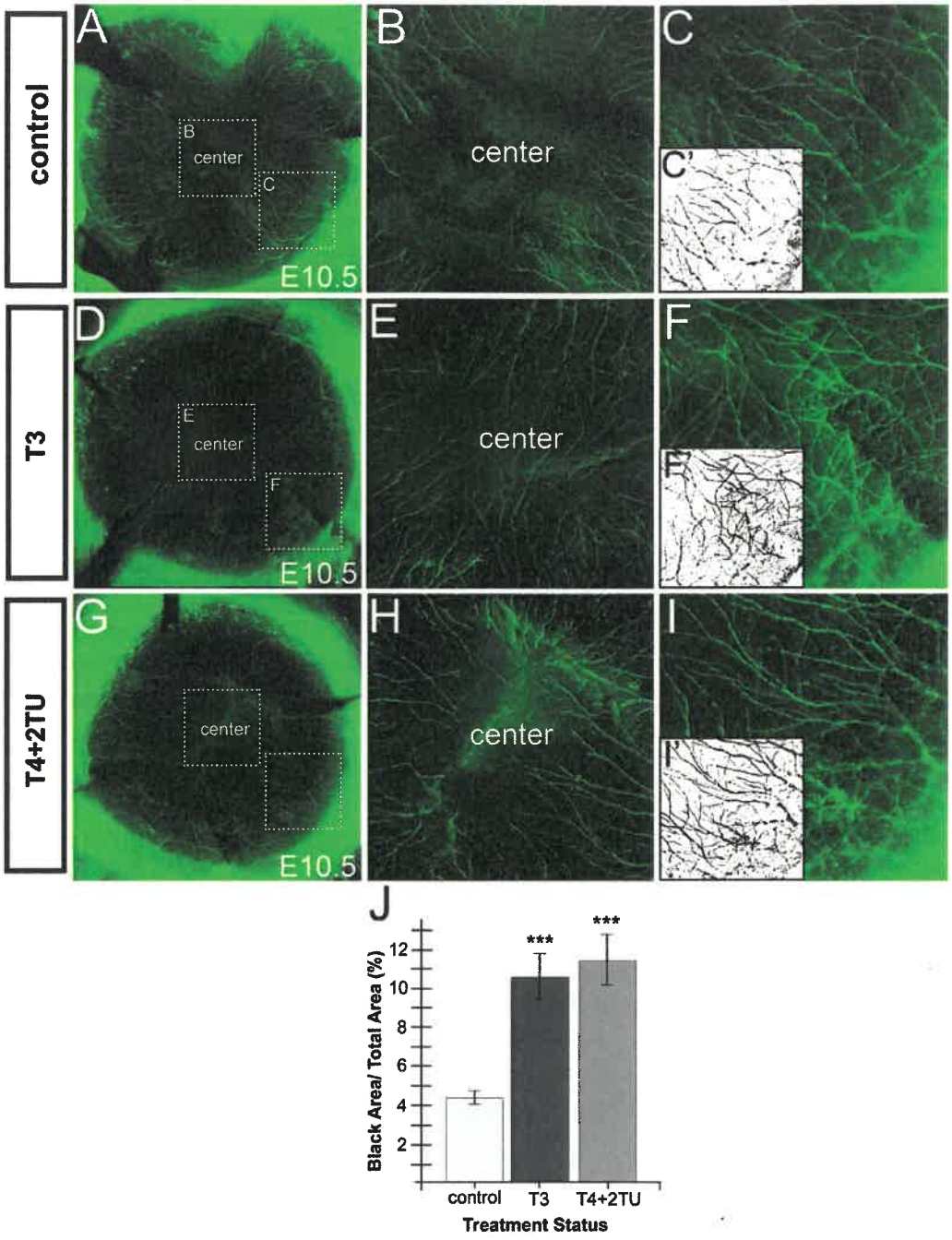
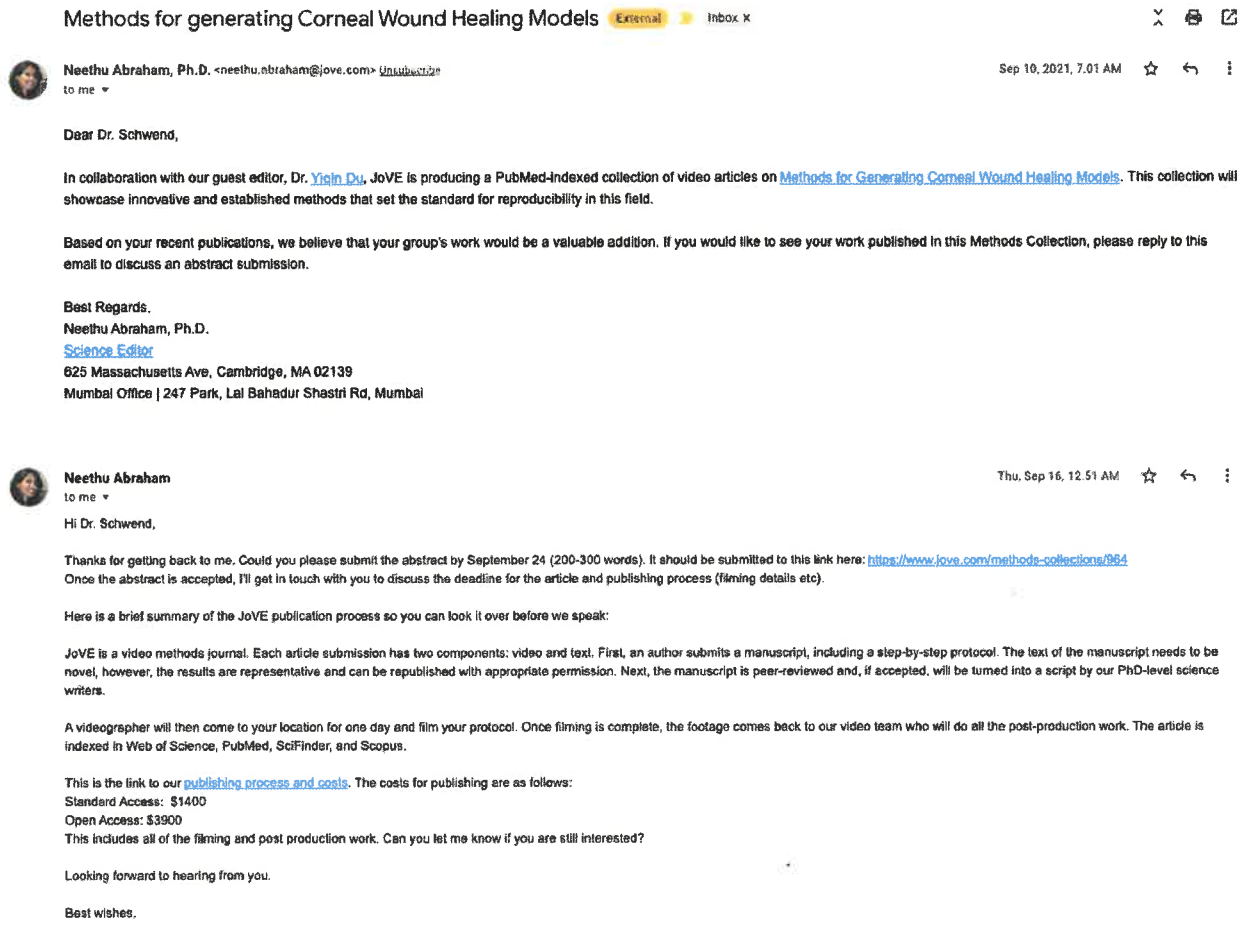


Figure 1. Thyroid hormone increases the rate of corneal innervation. (A-C) Corneal nerves (green) are visualized using fluorescent microscopy at daily intervals, beginning at embryonic day 9 (E9) through embryonic day 11 (E11) in control corneas. (D-I) Corneal nerves are visualized at daily intervals (E9-E11) in T3 or T4+2TU-treated corneas. These treatments both effectively raise the levels of thyroid hormone in the chick embryo. Note that nerves in T3 or T4+2TU-treated corneas have extended further toward the corneal center when compared to controls.

Email communication with JoVE editor

The following are screenshots of communication between Dr. Neethu Abraham, editor for JoVE and myself. The selected screenshots include:

Sept 10 – The original invitation from Dr. Abraham on behalf of JoVE to submit a methods article. A formal abstract was requested.
Sept 16 – Details about the standard access publishing costs ($1400) for which I am seeking ASD funds.
Sept 27 – Confirmation that my formal abstract was accepted and my article is tentatively entered into the methods collection.
Sept 30 – Notice of an official invitation for publication. Deadline for written manuscript set at November 8, 2021. Further details about the publication process are provided.



Methods for generating Corneal Wound Healing Models External Inbox ×

Neethu Abraham, Ph.D. <neethu.abraham@jove.com> Unsubscribe
to me

Sep 10, 2021, 7:01 AM

Dear Dr. Schwend,

In collaboration with our guest editor, Dr. Yiqin Du, JoVE is producing a PubMed-indexed collection of video articles on Methods for Generating Corneal Wound Healing Models. This collection will showcase innovative and established methods that set the standard for reproducibility in this field.

Based on your recent publications, we believe that your group's work would be a valuable addition. If you would like to see your work published in this Methods Collection, please reply to this email to discuss an abstract submission.

Best Regards,
Neethu Abraham, Ph.D.
Science Editor
625 Massachusetts Ave, Cambridge, MA 02139
Mumbai Office | 247 Park, Lal Bahadur Shastri Rd, Mumbai

Neethu Abraham
to me

Thu, Sep 16, 12:51 AM

Hi Dr. Schwend,

Thanks for getting back to me. Could you please submit the abstract by September 24 (200-300 words). It should be submitted to this link here: https://www.jove.com/methods-collections/964
Once the abstract is accepted, I'll get in touch with you to discuss the deadline for the article and publishing process (filming details etc).

Here is a brief summary of the JoVE publication process so you can look it over before we speak:

JoVE is a video methods journal. Each article submission has two components: video and text. First, an author submits a manuscript, including a step-by-step protocol. The text of the manuscript needs to be novel, however, the results are representative and can be republished with appropriate permission. Next, the manuscript is peer-reviewed and, if accepted, will be turned into a script by our PhD-level science writers.

A videographer will then come to your location for one day and film your protocol. Once filming is complete, the footage comes back to our video team who will do all the post-production work. The article is indexed in Web of Science, PubMed, SciFinder, and Scopus.

This is the link to our publishing process and costs. The costs for publishing are as follows:
Standard Access: $1400
Open Access: $3900
This includes all of the filming and post production work. Can you let me know if you are still interested?

Looking forward to hearing from you.

Best wishes,

(Emails from JoVE continued)

Neethu Abraham Sep 27, 2021, 1:42 AM (13 days ago)
to me

Hi Dr. Schwend,

Dr. Du has accepted your abstract. Her comments are as follows: "Embryonic corneal wound is a very useful tool to study scarless corneal wound healing.
There are papers on this topic but a video paper in JoVE would be very helpful to this field."

Can we schedule a short zoom meeting to discuss the publishing process and a tentative submission deadline? We can also communicate via email. After our discussion, I will send the instructions and an official invitation for publication. Looking forward to hearing from you.

Neethu Abraham, PhD
Science Editor | JoVE

Mumbai Office | 247 Park, Lal Bahadur Shastri Rd, Mumbai
Headquarters:1 Alewife Center Suite 200 Cambridge MA 02140 USA

Neethu Abraham Sep 30, 2021, 2:27 AM (10 days ago)
to me

Hi Dr. Schwend,

I have sent an official invitation for publication with the deadline set to November 8th. **I have attached the template that you can use to prepare the text manuscript and an example manuscript. If you have specific questions, please let me know and I will answer them via email/call.**

Please go through the instructions to the authors (attached document) and the process carefully before preparing your manuscript.

1. An original manuscript is submitted first, and must complete internal editorial review and then external peer review to be accepted for publication

2. Your first step is just to put together the text manuscript, and we'd film after the text passes peer review.

3. What we would require from you is a unique manuscript, the bulk of which is a step-by-step methods section, written in as much detail as possible. We do not require novel results, only representative results, and the manuscript is typically 8-9 pages long. You could reuse previously published figures as long as you cite the source and get copyright permission.

4. After submission, the process usually takes about 6 months. The manuscript goes through internal review, out for peer review (we would ask you to suggest 3 reviewers), and once accepted, a PhD level scriptwriter will create a script and storyboard.

5. Around 3-4 months after submission, we will schedule a videographer to come out to your location for one day of filming, usually 6-8 hours.

6. The footage comes back to us and we do all the video editing and add a professional voice-over. It's published on our website and then indexed in Web of Science, PubMED, Scifinder, and Scopus. You get your own copy of the video that you can post on your website for academic purposes and use for presentations, conferences, teaching, and training.

Tyler Schwend
Center for Natural Sciences, C109A (309)258-9641
Bloomington, IL Illinois Wesleyan University tschwend@iwu.edu

Professional Experience and Education

Associate Professor, Biology 2021 – present
Illinois Wesleyan University, Bloomington, IL

Assistant Professor, Biology 2016 – 2021
Illinois Wesleyan University, Bloomington, IL

Assistant Professor, Biology (tenure track, left position for IWU) 2015 – 2016
Hope College, Holland, MI

Postdoctoral Fellow, Comparative Biosciences 2012 – 2015
University of Illinois, Urbana, IL

Postdoctoral Fellow, Biology 2010 – 2012
Kansas State University, Manhattan, KS

Ph.D. in Life Sciences 2004 – 2009
Northwestern University Feinberg School of Medicine, Chicago, IL

Bachelor of Science in Biology 1999 – 2003
University of Illinois, Urbana, IL

Peer Reviewed Research Publications

***mentored undergraduates**

2020 *Patel, M., *Pham, N., *Ziegenhorn, E., Deaton, R.J., *Pisano, A., *Kim, S., *Rajarathnam, V., and **T. Schwend**. Unique and Overlapping Effects of Triiodothyronine (T3) and Thyroxine (T4) on Sensory Innervation of the Chick Cornea. ***Experimental Eye Research*** 194:108007.

2016 Jin, Z., **Schwend, T.**, Fu, J., Zhao, H., Mei, W., and J. Yang. Members of the Rusc protein family interact with Sufu and inhibit vertebrate Hedgehog signaling. ***Development*** 43(21):3944-3955.

2015 Mao, X., Zhang, Y., **Schwend, T.**, and G.W. Conrad. Effects of Polysialic Acid on Sensory Innervation of the Cornea. ***Developmental Biology*** 398(2):193-205.

2013 **Schwend, T.**, Jin, Z., Jiang, K., Mitchell, B.J., Jia, J., and J. Yang. Stabilization of Spop by Dzip1 is required for Gli turnover and the proper output of Hedgehog signaling. ***Journal of Biological Chemistry*** 288: 32809-32820.

Mei, W., Jin, Z., Lai, F., **Schwend, T.**, Houston, D., King, M.L., and J. Yang,. Maternal Dead End 1 is required for vegetal cortical microtubule assembly during Xenopus axis specification. ***Development*** 140 2334-2344.

Zhang, Y., Mao, X., **Schwend, T.**, Littlechild, S., and G.W. Conrad,.Resistance of Corneal RFUVA-Crosslinked Collagens and Small Leucine-rich Proteoglycans to Degradation by Matrix Metalloproteinases. ***Invest. Ophthalmol. Vis. Sci.*** 54(2):1014-1025.

2012 **Schwend, T.**, Deaton, R.M., Zhang, Y., Caterson B., and G.W. Conrad, (2012). Corneal Sulfated Glycosaminoglycans and their Effects on Trigeminal Nerve Growth Cone Behavior *In Vitro*: Roles for ECM in Cornea Innervation. ***Invest. Ophthalmol. Vis. Sci.*** 53(13):8118-8137.

Mao, X., **Schwend, T.**, and G.W. Conrad. Expression and Localization of Neural Cell Adhesion Molecule and Polysialic Acid during Chick Corneal Development. ***Invest. Ophthalmol. Vis. Sci.*** 53(3) 1234-43.

Schwend, T., Lwigale, P.Y., and G.W. Conrad. Nerve Repulsion by the Lens and Cornea during Cornea Innervation is dependent on Robo-Slit Signaling and Diminishes with Neuron Age. ***Developmental Biology*** 363(1):115-27.

2011 **Schwend, T.*,** Loucks, E.J.*, *Snyder, D., and S.C. Ahlgren. Requirement of Npc1 and Availability of Cholesterol for Early Embryonic Cell Movements in Zebrafish. ***Journal of Lipid Research*** 52(7):1328-1344. (* *denotes equal authorship*)

2010 **Schwend, T.**, Loucks, E.J., and S.C. Ahlgren. Visualization of Gli activity in craniofacial tissues of Hedgehog pathway reporter transgenic zebrafish. ***PLoS One*** 5(12): e14396.

Camarata, T., *Snyder, D., **Schwend, T.,** Klosowiak, J., Holtrup, B., and H.G. Simon. Pdlim7 is required for maintenance of the mesenchymal/epidermal Fgf signaling feedback loop during zebrafish pectoral fin development. ***BMC Dev Biol.*** 10:104.

2009 **Schwend, T.,** and S.C. Ahlgren, (2009). Zebrafish *con/disp1* reveals multiple spatiotemporal requirements for Hedgehog-signaling in craniofacial development. ***BMC Dev Biol.*** 9(1):59.

2007 Loucks, E.J., **Schwend, T.,** and S.C. Ahlgren, (2007). Molecular changes associated with teratogen-induced cyclopia. ***Birth Defects Research A: Clinical and Molecular Teratology.*** 79: 642-651.

Selected Awards and Research Grants

- IWU Eckley Scholarship (research mentor to recipient Anjali Patel) 2021
- IWU Artistic and Scholarly Development Grant 2019
- Soc. Develop. Biology Travel Award to Research Conference 2018
- IWU Curriculum Development Grant (**awarded twice**) 2016 and 2017
- IWU Eckley Scholarship (research mentor to recipient Mansi Patel) 2017
- IWU Library Research Award (research mentor to recipient Mansi Patel) 2017
- National Institutes of Health Postdoctoral (F32) Research Fellowship 2011-2014
- National Institutes of Health Predoctoral (F31) Research Fellowship 2007-2009

ASD Grant Budget Page

Faculty Name(s) Tyler Schwend

Project Title Show and Tell: Publishing a Video Methods Article on Corneal Wound Healing and Regeneration

A. Equipment Description (please give source of recent estimate) $0

B. Supplies and Services (please itemize) $~475

Fertile eggs ($30.00)
Syringes/needles ($40.00)
Forceps ($260)
Microknife ($143)

C. Travel Expenses (please itemize) $0

D. Consultancy Fees $0

E. Living Expenses (see proposal guidelines) $0

F. Student Wages (see proposal guidelines) $0

G. Faculty Stipend (maximum $2,000 per faculty Member) $600

H. Publication Expenses $1400

I. Other $

TOTAL $2,475

(Maximum award $3,500 per individual or $5,500 for a joint proposal from two or more faculty members)
NOTE: List all expenses, even if the total exceeds the maximum grant. If your budget exceeds the maximum grant, explain how you will make up for the shortfall.

ILLINOIS WESLEYAN UNIVERSITY

September 16, 2019

Dr. Tyler Schwend
Department of Biology
Illinois Wesleyan University
Bloomington, IL 61701

Dear Dr. Schwend:

This letter serves as an approval of your Protocol 19-009: *Extracellular matrix and diffusible guidance molecules in chick cornea development.* These protocols were read by Committee Members Blanchard, Dehm, Duke, Fraker, Kerr, and Skolmoski and you have answered all questions raised by those individuals. You are approved as of September 16, 2019 for carrying out this experiment. Approval of this protocol will expire three years from now on September 16, 2022.

Sincerely,

Abigail Kerr
Chair, IACUC