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The Art in Science: The University of Michigan's BioArtography Project

By Deborah L. Gumucio, PhD

From 64,000-year-old Neanderthal cave drawings or Egyptian hieroglyphics, to Michelangelo's "Vitruvian Man" or Picasso's cubist paintings, various forms of art have been used to teach, record, warn, stimulate, challenge and inspire people throughout the ages.

Indeed, art is widely considered a universal tool of communication. We argue here that we, as scientists and health care professionals, can (and should!) use art to convey information about our important discoveries and the field's best practices to the public.

We — that is, most scientists and some clinicians — are notoriously poor public communicators. While we effectively utilize journal publications and professional meetings to announce our exciting new findings to each other in a timely manner, the public rarely hears about promising new research studies until years later, when specific practices or therapeutics come to fruition.

Yet people are missing out on the excitement of our ongoing work. Our public communication is also hampered by the fact that we are trained to speak to one another in increasingly field-specific jargon; this language barrier further interrupts any meaningful exchange of information with a general audience.

Moreover, researchers who work with model organisms, e.g., yeast (*Candida*), fruit flies (*Drosophila*), or worms (*C. elegans*), must begin any discussion by justifying to a skeptical public how and why these simple organisms can be such valuable tools for the investigation of basic problems in human health. Sadly, there are precious few opportunities for meaningful crosstalk between scientists and the public. Seldom do we take the considerable time that is needed to explain, in lay language, our excitement about new research findings and their potential implications for human health. Extending the problem generationally, teaching our trainees how to speak clearly to the public about their science is not a common goal of our training curricula.

What is needed is a platform that allows exchange of information between scientists and the public about discovery science in real time. Such a platform would ensure that the public is informed, up-to-date, and, moreover, is empowered to advocate for researchers as we struggle to gain support for important research directions. This platform needs to be engaging, eye-catching, informational, understandable, and widely available.

We submit that art, that universal mode of communication, provides a wonderful tool to accomplish these objectives. In this vein, we have introduced the BioArtography Project at the University of Michigan.

BioArtography in a nutshell

BioArtography was initiated in 2005 as a blend of art and science, initially intended as a much-needed fundraiser to raise travel money to help send trainees to national meetings, where they could present their work and network with leaders in their fields. Indeed, more than 120 trainees have benefited from such awards over the ensuing 17 years. Candidate images for the BioArt gallery are donated each year by researchers all over the University of Michigan and beyond. Most represent pictures of cells and tissues taken under a microscope by investigators during the course of their research.

Images come from a wide variety of disciplines, including medicine,

Art, that universal mode of communication, provides a wonderful tool to allow the exchange of information between scientists and the general public. Enter the BioArtography Project, a unique interface that has served to bring ongoing science to the people in a way that interests them and in a format they can understand.

dentistry, genetics, chemistry, engineering, and nanotechnology. Some photographs are subjected to photoshop manipulation by BioArt staff to enhance their impact. From the palette of more than 100 images submitted each year, a jury of experts from the University of Michigan School of Art selects the 10-12 most striking for addition to the official gallery. You can find this gallery at www.bioartography.com.

Each selected image is accompanied by a paragraph, written in lay language, that describes the work behind the image, clearly communicating both the scientific problem that drives the research as well as its potential for impact on human health. Currently, the gallery contains more than 200 images, representing numerous types of cells, tissues, and model organisms. All of the images (and their accompanying informational paragraphs) may be purchased as framed work, canvas prints, glass prints, gift cards, scarves and more, with all proceeds designated for trainee travel.

Reaction is fascinating

An important part of the BioArtography mission is the actual interface with the public. This is done via the website noted above, through sales at local art shows, as well as through exhibitions at museums or coffee shops and lectures to interested groups (camera clubs, foundation fundraisers, senior living facilities, junior high and high school classrooms).

The Ann Arbor Summer Art Fair, which draws nearly a million people each July, is a central pillar of this effort. More than 40 volunteers including faculty, staff, students, and postdocs brave the summer heat to staff the booth and talk to the public about the science. For many it is their first

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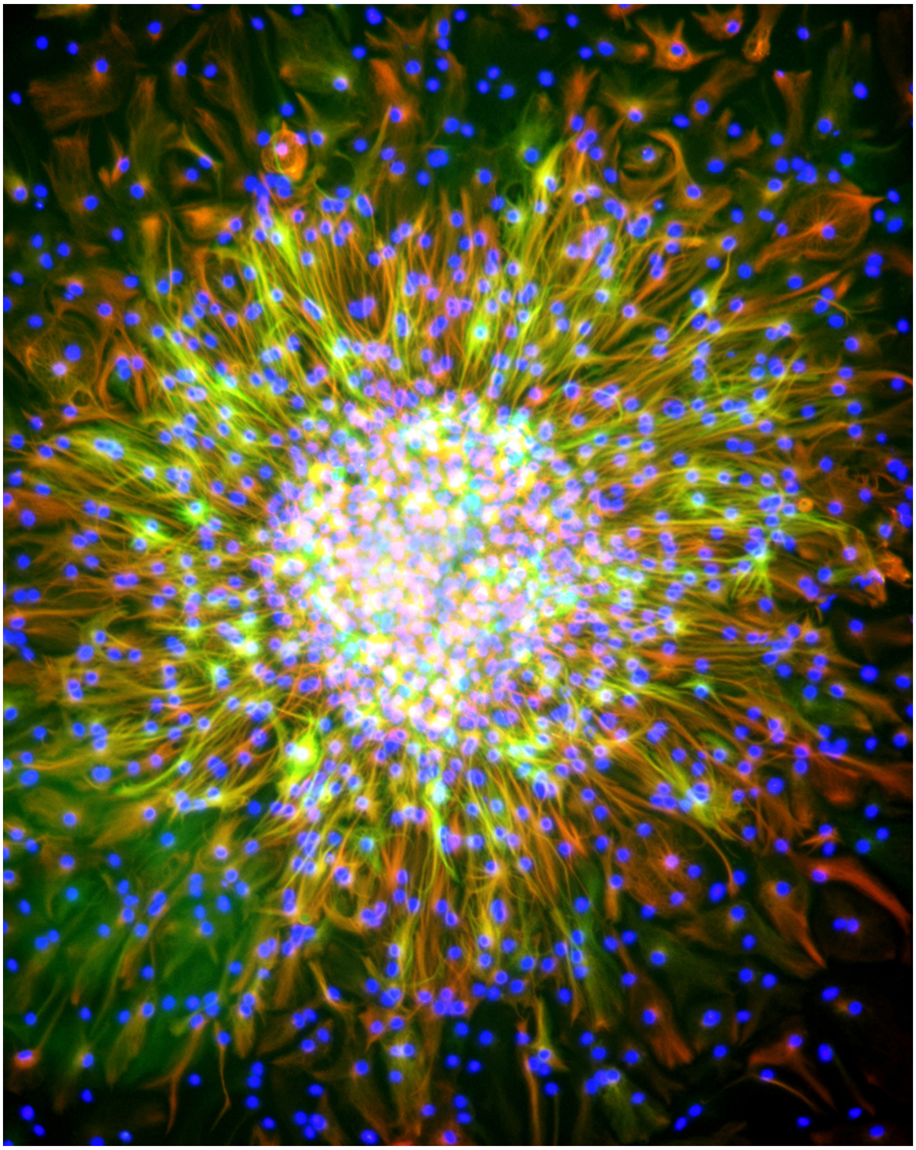
Figure 1 — Thistle



Description: Induced pluripotent stem cells represent a relatively recent and extremely powerful addition to the toolbox of investigators who wish to study human disease and seek new therapies. Essentially, this technology allows researchers to take a skin biopsy from a patient, place it in a culture dish in the laboratory, and add factors/chemicals that force the cells to "forget" their skin identity and start behaving like embryonic stem cells (cells that, as in the embryo, are pluripotent, meaning that they can give rise to any cell type in the body). Once in this "undifferentiated" state, the cells can be further manipulated to make any desired cell type. In this image, a colony of stem cells is differentiating into neurons (nerve cells, green) and astrocytes (supporting cells, orange). The same technology is now being used to aid in the regeneration of teeth and periodontal tissue.[1]
—Maria Morrell, PhD, postdoctoral research fellow, Department of Cell and Developmental Biology, University of Michigan Medical School.

experience in finding the words to explain their discoveries in lay language to interested, non-scientist observers.

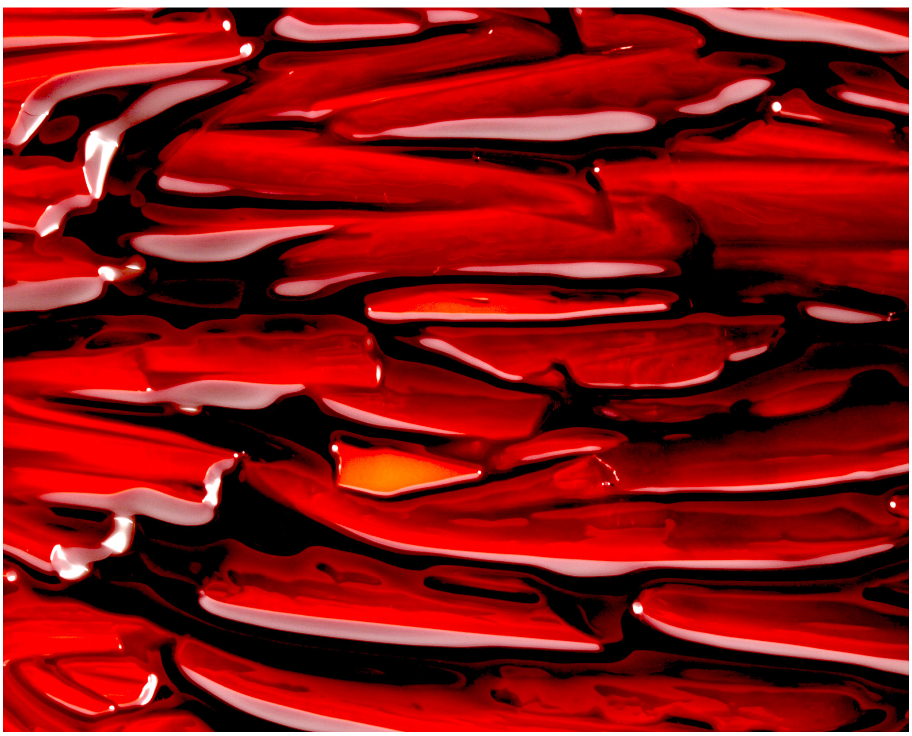
The public reaction to these images is always fascinating. The colors and symmetry of many cells and tissues as presented in these pictures is an immediate draw for people walking by the booth. As someone peers closely at a compelling image such as the "Thistle" photograph (Figure 1, see Page 49), a volunteer booth worker may say, "These are stem cells growing in a dish in the laboratory; they are being coaxed to form neurons of the brain." From there, the questions begin to flow . . . *Where do the stem cells come from? Are the cells that grow out just like the ones in our brain? Can these cells be used to cure brain diseases such as Parkinson's?*

In response, the volunteer can explain how new technologies are allowing investigators to generate stem cells that are pluripotent (able to form any cell in the body) from skin biopsies of patients with a disease — for example, bipolar disease. These so-called "induced pluripotent stem cells" are then patient-specific; they can be further pushed to become brain or heart or gut or kidney or an almost endless number of cell types. Once that is accomplished, the function of the patient's cells can be compared to the function of similar cells generated from individuals without the disease. Thus, the effects of the disease can be studied in a dish without the need to perform experiments on patients themselves.

Even more compelling is the idea that, once abnormalities in patient cell function are identified, it is possible to test libraries of small molecules for their ability to reverse these abnormalities in the patient's own cells in a dish — personalized medicine! From there, a wide-ranging discussion can ensue, including the potential for stem cell therapies, as well as the use of these stem cells to form organoids in a dish. A recent article on the applications of induced pluripotent stem cells in dentistry makes an interesting read.[1]

Many of these concepts are totally new to the public. Some of the ideas, such as that pluripotent stem cells resemble embryonic stem cells, are concerning or off-putting, since at least some people associate embryonic stem cells with the destruction of embryos. Such a discussion, in front of a beautiful image like "Thistle," provides a chance to dispel this myth and provide information about how these pluripotent cells are derived from skin biopsies, not embryos.

Figure 2 — The Reason They Invented the Toothbrush



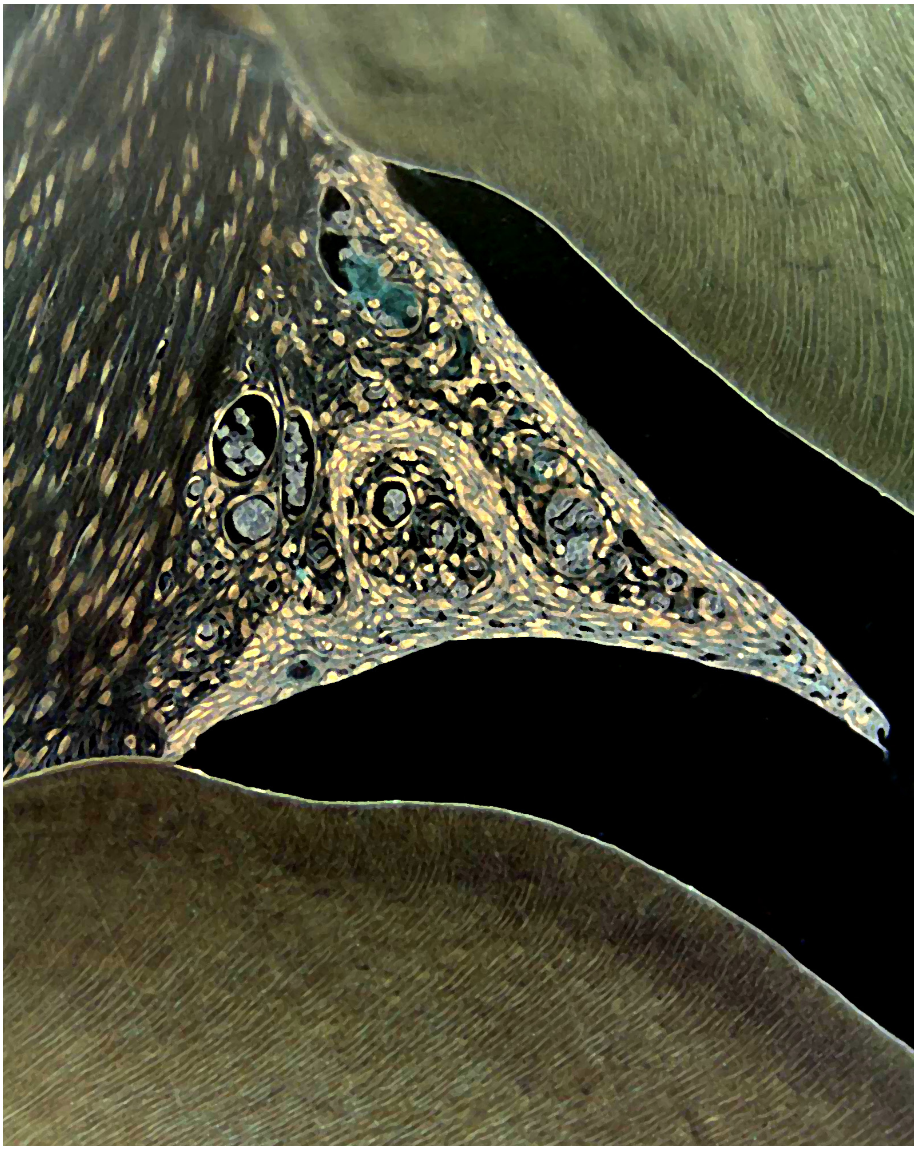
Description: *Porphyromonas gingivalis* is a bacterium that is present in high numbers in the mouths of people with gingivitis and periodontitis, which is a major cause of bad breath and tooth loss. This is a close-up image of the bacteria being cultivated in the laboratory in agar dishes infused with blood from sheep, which is ideal for the bacteria growth. *P. gingivalis* loves growing in places with food and blood (like unclean teeth!) and will turn black by processing hemoglobin from the blood and storing it on its surface. The destruction that *P. gingivalis* wreaks may go far beyond gum disease, however. Studies have suggested links between *P. gingivalis* infection and pancreatic cancer, diabetes, rheumatoid arthritis, and even Alzheimer's disease.[2-10]

—Julie Marchesan, graduate student (Giannobile Laboratory), Oral Health Sciences Program, University of Michigan School of Dentistry.

Providing public health messages

Many of the images in the BioArt collection carry compelling public health messages. For an audience of scholars in the dental field, "The Reason They Invented the Toothbrush" (Figure 2) tells an important story about growing evidence for the con-

Figure 3 — Toothy



Description: The pointed structure in the center of this photograph is part of the gingiva, or the gum, between two teeth of a rat. Keeping this tissue healthy with regular brushing and flossing is important. Gingivitis may occur when plaque builds up on teeth. Plaque contains bacteria, which secrete molecules that cause inflammation of the gingiva. Left untreated, gingivitis can lead to a more serious condition known as periodontitis. Research has shown that, in response to the bacteria in plaque, specific cells in the gingiva (colored yellowish grey in this image) secrete a protein called stromal derived factor-1 (SDF-1). Indeed, it has been shown that SDF-1 is expressed at higher levels in animal models of gingivitis and is reduced upon resolution of the irritation. Interestingly, it appears that SCF-1 actually participates in the inflammatory damage since it recruits blood cells that cause localized inflammation.[11,12] Thus, although it is a bad guy in this story, SDF-1 can be a helpful biomarker for clinicians who want to follow the state of the inflammatory therapeutic process. Additionally, it is possible that strategies that reduce the levels of SDF-1 could be of benefit.

—Jason Wang, research laboratory specialist (Gionnobile and Taichman laboratories), University of Michigan School of Dentistry.

nection between gingivitis and several systemic diseases, including Alzheimer's disease, diabetes, rheumatoid arthritis, and pancreatic and colon cancers.[2-10] In another case, "Toothy" (Figure 3) presents part of the mechanism underlying the inflammation that accompanies gingivitis. This image explains how a protein, SDF-1, produced by cells within the gums in response to bacteria residing in dental plaque, can attract blood cells that produce the irritation and redness that accompanies gingivitis.[11,12]

Finally, "On the Tip of Her Tongue" (Figure 4, see Page 52) provides a look into the fetal development of taste buds on the tongue, using a rat organ culture model. This image can provoke a further exchange about the loss of taste seen in some people with COVID-19, a symptom that is still being actively investigated.

Personalizing the science

In addition to framed prints, canvas wraps, and images printed directly on glass, some BioArtography images are available as silk scarves, gift cards and coasters. The public response to the scarves has been particularly striking, as they provide the opportunity to "wear a disease," making the art/science connection much more personal. An example of this

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came recently at a small art show in which a woman was drawn to the scarf version of "Can You Hear Me Now?" (the original image is shown in Figure 5,). The woman approached the booth, attracted by the colors in the scarf, saying "This is just beautiful — what is it?" When told that the image represents a mouse model of pancreatic cancer that is providing clues to how to suppress the progression of that deadly disease, the woman teared up. "My husband died of pancreatic cancer two years ago" she explained. "This gives me hope that something can be done for others. I just have to have it."

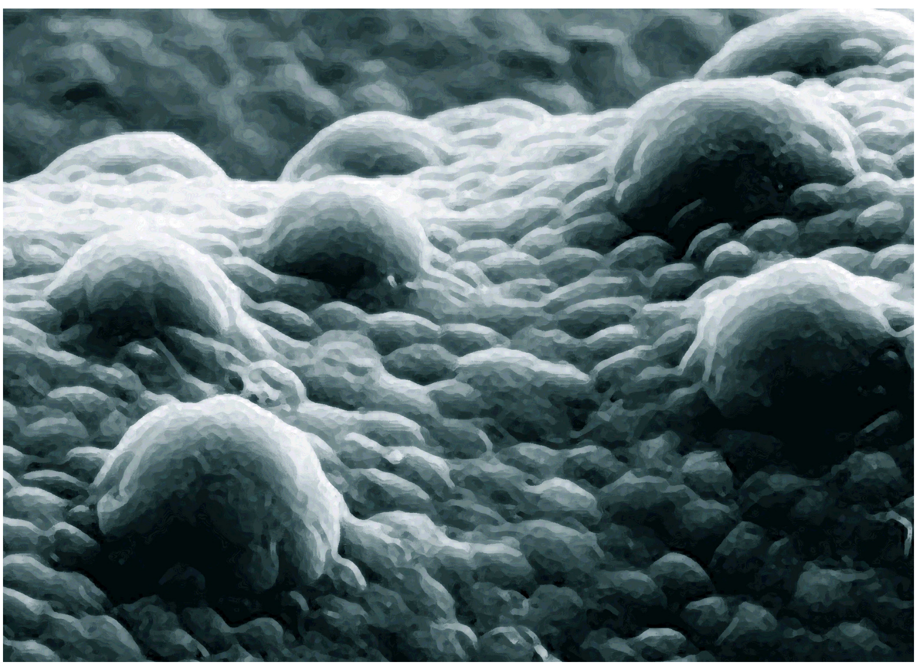
Several other scarves on the BioArtography website, depicting progressing research in bipolar disease ("Bipolar Windows"), macular degeneration ("Seeing the Light"), asthma and COPD ("Sweeper") and diseases of the bone marrow ("Deep in My Bones") have had similar responses from the public.

Stimulating public imagination

Altogether, the BioArtography Project has served to bring ongoing science to the people in a way that interests them and in a way that they can understand. BioArt stimulates the public imagination while conveying information about novel discoveries, introducing promising treatments, and promoting healthy practices. It also provides much-needed background about sensitive or difficult topics, while simultaneously teaching scientists and professionals how to start an informative dialog on those issues. It may also be obvious by now that in the office or clinical setting, BioArtography images on a bare spot on the wall can launch communication.

As Albert Einstein said, "The greatest scientists are artists as well." BioArtography embraces that thought and gives it wheels. With this collection, we strive to create a more informed community — one challenged and invigorated by a deeper understanding of science and medicine, and a greater appreciation of art. ●

Figure 4 — On The Tip of Her Tongue



Description: The sense of taste is essential to identify the nutrients that our bodies require, and to reject some chemicals that are noxious. Taste is mediated by taste buds that reside in structures called taste papillae on the tongue, but precisely how these structures develop in the embryo is still unclear. This is a scanning electron micrograph of the surface of the tongue of a rat embryo. The large mounded structures are early developing taste papillae (fungiform papillae, to be precise) in a tongue organ culture system. The organ culture is useful because it allows us to observe papilla development in the dish, where molecules can be added or subtracted to understand how papilla formation is regulated.
—Charlotte Mistretta, PhD, professor of dentistry, University of Michigan School of Dentistry.

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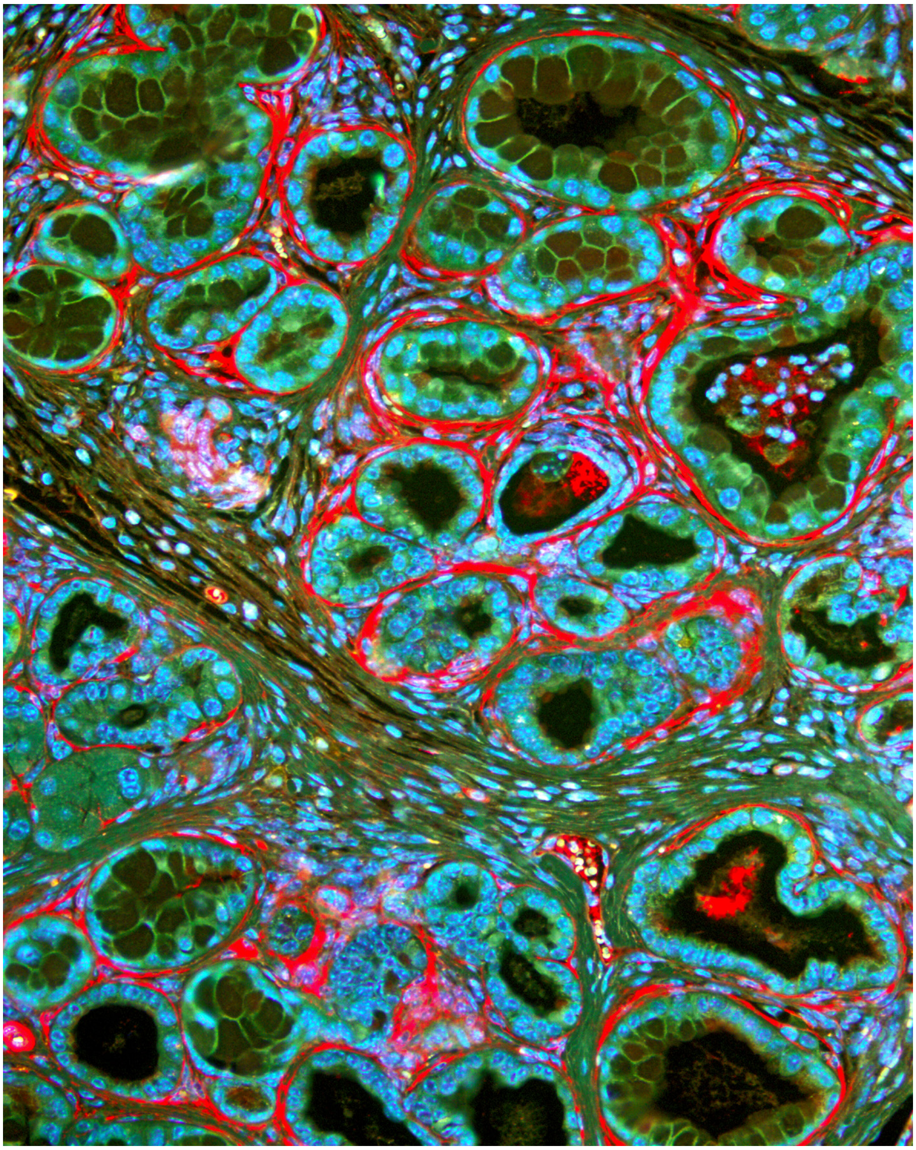
Figure 5 — Can You Hear Me Now?



Description: This is a microscopic image of pre-cancer in a mouse pancreas. The green, bubbly looking cells arranged in clusters are pre-cancerous cells. These cells secrete factors that recruit activated fibroblasts (red). The incoming fibroblasts closely surround the tumor cells and send messages back to the tumor cells to further promote tumor growth. An important goal of ongoing work is to understand the cell-to-cell communication that allows the pre-cancerous cells to recruit fibroblasts and the mechanisms by which these recruited fibroblasts reinforce tumor growth. Interestingly, there are hints that oral health and pancreatic cancer are linked.[4-9] Studies have shown that people with higher levels of antibodies to certain strains of *Porphyromonas gingivalis*, the bacteria that causes gingivitis, are at increased risk for pancreatic cancer. It is not clear yet whether the presence of *P. gingivalis* is a causative link to this cancer or an associated biomarker.
—Li-Jyun Syu, PhD, research laboratory specialist (Dlugosz laboratory), Department of Dermatology, University of Michigan Medical School.

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