ACS AMA: Hi Reddit! We are Sylvia Daunert, Suzana Hamdan, and Irena Pastar of the University of Miami. Ask us anything about using nanotechnology to heal wounds!

AmerChemSocietyAMA [1] and r/Science AMAs[1]

[1]Affiliation not available

April 17, 2023

Abstract

ACS AMA Hello Reddit! We are Sylvia Daunert, Suzana Hamdan, and Irena Pastar of the University of Miami Miller School of Medicine. In February 2017, we published our research in ACS Central Science, an open access journal, entitled "Nanotechnology-Driven Therapeutic Interventions in Wound Healing: Potential Uses and Applications" We look forward to answering your questions about this research today! To introduce ourselves, alphabetically by surname: I am Sylvia Daunert and I am the Lucille P. Markey Chair of Biochemistry and Molecular Biology, as well as the Associate Director of the Dr. JT Macdonald Biomedical Nanotechnology Institute at the University of Miami. My group's research focuses on the development of bio-inspired nanotechnologies to solve biomedical and environmental problems. We genetically engineer living cells and proteins for environmental detection, molecular sensing, molecular diagnostics, point-of-care tests, biomarker identification, and targeted and responsive drug delivery. We recently developed a nanocarrier-based method for the targeted delivery of stem cells for wound healing. The technology, while widely applicable to a variety of wounds, was first demonstrated in diabetic wounds and in animal models of corneal and retinal injury. I was a Fulbright Scholar at the University of Michigan, and awarded my Ph.D. in bioanalytical chemistry at the University of Barcelona in Spain. I am Suzana Hamdan and I am a Postdoctoral Associate in the Daunert Research Group at the University of Miami Miller School of Medicine. My current research interests focus on the biological studies of nanomaterials derived from pharmaceutical drugs. In fall 2007, I received a Master of Science degree from East Tennessee State University, and was awarded a Ph.D. degree in May 2015 from the chemistry department at Louisiana State University. During my graduate studies, I developed novel techniques for size-control of nanoparticles derived from organic salts, and designed molecularly imprinted polymeric nanoparticles for chiral recognition of biological targets. I am currently the author of eight published scientific papers, with a special focus on nanotechnology and analytical chemistry fields. I am Irena Pastar and I am an Assistant Professor at the University of Miami, Department of Dermatology and Cutaneous Surgery. Our department has developed an unique wound healing research program focused on understanding the nature of non-healing wounds at the cellular and molecular levels. We have also been active in a variety of pre-clinical studies and clinical trials evaluating bioengineered products, drugs, dressings and devices important to wound repair. After receiving my Ph.D. in molecular microbiology and completing a postdoctoral fellowship in immunology at the Rockefeller University, I pursued translational research in cutaneous wound healing. My research focuses on the molecular pathophysiology of chronic wounds and cutaneous infections. I am a leading investigator and co-investigator on multiple federal and industry sponsored studies on novel wound healing therapeutics and chronic wound pathogenesis. Ask us anything about using nanotechnology to heal wounds! We will be back at 12pm ET (9am PT, 5pm UTC) to answer your questions. Hi Reddit! Sylvia, Irena, and I are online , and happy to answer your questions! Hello Reddit Users, We are logging off for a while, but will be back later to answer your questions. Thank you for your interest in our field! Irena, Suzana and Sylvia Hi Reddit! We are back online again and ready to answer more questions! We are logging off for now, we might answer few more questions later on. We would like to thank all who participated in our AMA Reddit today and apologize to those who did not get an answer due to a lack of time to get to all questions. Hope you continue your interest in nanotechnology and keep on supporting research. It is really important to us and our global scientific community! Thanks again, Suzana, Irena and Sylvia

the WINNOWER

REDDIT

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ACS AMA

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Hi

Thanks for participating in this AMA!

Are you able to provide an ELI5 as to how nanotechnology helps in wound healing, and is superior to conventional therapies?

Thanks in advance!

mvea

Thanks for the question! There are several ways to explain how nanotechnologies help in wound healing. Mainly, the use of nanomaterials (materials at a scale usually below 100 nm) for wound healing has many advantages specifically due to their small scale that increases their biological activities, and enhances their interactions with the target cells.

At what point do you see this technology developed enough for human trials?

jroche15m

There are currently some nanotechnologies that are going to clinical trials. For example, one of the studies is the use of liposomes to deliver microRNA for wound healing. We expect the extension of nanotechnologies into the clinic very soon.

Are there any problems associated with trying to remove nanoparticles from the body? I understand toxicity has always been a major obstacle in biotechnology, so are there toxic effects in your research that you don't fully understand?

brainstormingLiszt

Nanoparticles are small and cleared by kidney or liver within few hours without any consequences. If there are any nanoparticles that are toxic, these materials can be surface modified by a molecule to decrease their toxicity.

What happens if the body rejects the technology?

Russell_Fisher

Before using the technologies in human, extensive studies are done to make sure there is no cytotoxicity or immunogenic response. This is strictly regulated by the FDA; therefore, there is no reason for rejection of the technology.

Can this tech be modified to target cancer cells, or be used to combat infections?

kiwinutsackattack

To answer the second part first, infection is a major deal that might obstruct wound healing. There have been many nanotechnologies that have been studied for this purpose especially in the case of drug delivery where nanoparticles were used to deliver antibiotics and antimicrobials. These nanotechnologies can be tuned/modified for targeting cancer cells, for instance the drug used can be an anticancer drug.

How soon could you see this technology implemented on a major scale? Could we expect to have do it yourself editions of nano technology for smaller wounds?

AsslessCraps

There are already some technologies that are advanced and in clinical trials already, and others are at different development phases. Typically once a technology is in clinical trials, it takes 3-5 years to get it approved and available to patients.

Can/could nanotechnology be used in the regeneration or maintenance of muscle tissue? If so, could it be used to help patients who have degenerated muscle from prolonged stays in bed, or even astronauts who lose muscle mass while in low/micro gravity?

MrWendelll

Yes, targeted delivery of nanoparticles to the skeletal muscle that carry muscle building substances is possible. Thus, in principle, administering these nanoparticles with muscle building substances could help patients with degenerated muscles as well as astronauts that are subjected to microgravity during space missions.

How do you direct the nanotech to target a specific region? Biomarkers, Magnets, etc.? How small of a region can you target?

CavalierEternals

We can target a specific organ or tissue in the body by first identifying molecules or receptors that are present in those. Ideally they should be distinct and unique to that organ or tissue. We then either find or design a recognition molecule that is selectively recognized by these receptors on the organ/tissue of interest. Then, we modify the nanoparticle carrying the therapeutic agent (also known as nanocarrier) with this molecule and so it is ready to be administered to the individual. Because the recognition molecule on the nanocarrier is able to recognize the receptors on the desired organ/tissue it essentially functions like a GPS. As the nanocarrier navigates through the body, the recognition molecule will be directing it only to the targeted desired location. We can target at the cellular level using these targeted delivery nanocarrier technologies.

From a sports point of view, how long will it be until nanotechnology replaces or enhances bodybuilding steroids/performance enhancing drugs?

Also, is it possible yet to use nanotechnology to reconnect cartilage to bone?
Thanks in advance.

EoinMoney

In order to enhance muscle delivery, a system can be developed for a targeted delivery of a

therapeutic agent to the muscle. Such technology exists, but we are not sure when it will be used in public.

Yes there are plenty of technologies that address bone healing.
you can check the links below. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4476906
https://medicalxpress.com/news/2017-02-bone-therapies-mimic-regeneration.html

I've had chemo therapy and now suffer from Raynaud syndrome which prevents bloodflow to the bloodvessels in my fingers and toe's when it gets cold(Pretty annoying). Could Nano technology in the near or distant future be used to fix me up?

HenkGC

yes this is possible. We published a paper recently that discusses the development of a nanocarrier to direct stem cells to the wound site. The system results in angiogenesis, promotes vascularization and repair of the tissue. That means there is an increase in blood flow so theoretically that can solve your problem

See the link below http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0154053

Hi thanks for spending your time on this.

Would it be possible to send nanotechnology into the body to find wounds and heal them and if so how?

Thanks -Jpv

Jpvegies

It is possible and it has been successfully utlizied. Nanoparticles coated with adhesive molecule recognizing E-selectin expressed on the 'wounded cell' were used to deliver stem cells to the wound site.

Does nanotechnology have a place in nervous system healing? What are the current fronts of research in the nervous arena?

zero_gravitas_medic

The answer is yes. Healing of the nervous system is part of the field of neuroengineering, which employs a lot of nanotechnology and biotechnology to address nervous system ailments. New technologies that regenerate neurons and establish connections between neurons are being developed and the field holds tremendous promise for finding cures.

How long do you think it will take this technology to become more accessible in the medical field? And what, if any, applications are being used today?

Thanks so much for doing this AMA! I've always found nanotechnology to be really interesting!

Spade6sic6

It all depends on how fast we can have FDA-approved nanotechnologies. Silver nanostructures are being used, and other nanotechnologies are under consideration.

How long will it take for this technology to lower in cost for real world application?- so it isn't just the ultra rich, military and athletes getting access to this.

fedornuthugger

Manufacturing of most of these nanotechnologies are quite cost-effective once they have been developed. What increases the cost is the research prior to the final development of the technology. Federal agencies like the NIH, NSF, DoD, DOE, and private non profit foundations sponsor in great part the research in this field. Federal sponsored research is key to the development of cost-effective technologies because the research leading to the final product is subsidized and then is not so marked up but he biotech and pharma industries. This is why it is crucial that the government does not cut funds for research. If they do, we will be in a lot of trouble with regard to advancing science and technology and having exorbitant costs for new therapies.

Skimming through Table 2 of your paper where many of the current nanotechnologies are listed, I'm curious as to how/why the body's immune system does not reject these metallic particles?

CapNickFury

Metallic nanoparticles are usually applied at small concentrations/ low dose, and considering the small size of these nanomaterials, the immune response will not be able to recognize them.

I know this question might sound a little ridiculous but I'm going to ask it anyway. With all the latest advancements in medical science e.g. CRISPR, 3D printed organs, nanotechnology and so on I wonder how close do you think are we to immortality?

Orevan

Advancements in nanotechnology and biomedicine are certainly prolonging human life span.

Will we have the technology in the next 30 years to re-grow an amputated limb?

Tripound

Yes, we believe that we will have technology to regrow limbs. All indicators point to that way. Earls have been grown in the laboratory as are other organs and tissues, even lungs, which have been implanted in pigs and shown to survive with the laboratory manufactured lungs. Science is developing at an exponential rate, so the limbs will come at some point in the future, I truly hope within the next 30 years.

Hi ! I'd just like to know if in the future, nanobots can eventually be used to combat diseases. And if so, how far are we away from it?

NoboThatHobo

Nanobots are essentially nanocarriers or nanoparticles modified to carry therapeutic agents that repair a diseased organ or tissue. In that regard, we already have some examples in the literature that show that, indeed we can combat infections, close wounds and heal other diseases. As mentioned above in another answer, there are some nanotechnologies that you could consider nanobots that are already

undergoing clinical trials, and, therefore are not too far from being able to get through the FDA approvals and market. Typically it takes 3-5 years to get through this process.

can using nanotechnology to routinely heal wounds cause reduced natural healing due to over reliance on nanotech?

astra118

We do not believe that this will be the case because the use of wound healing nanotechnology approaches, in general, does not suppress natural pathways of healing, on the contrary, it promotes the process.

Are there any potential risks or downsides to using nanotechnology for healing that you're concerned about?

justAHairyMeatBag

No, as long as the research is done properly and the technologies are first being evaluated in animals for toxicity and immune response and statistically properly assessed.

(How) can this technology be used to reconnect severed nerves like ones in an organ or limb transplant?

leonardo_pothead

Neuroengineering is an area of biomedical engineering that has as once of their focus the reconnection of neurons, either severe by accident or degeneration. Neuroengineering employs a lot of nanotechnology strategies, either by developing and using devices at the nanoscale or implanting or delivering therapeutic agents that will regenerate and repair the neural tissues. In case of organ or limb transplants, there is stem cell technology that has been already used in diabetes. Also islet transplantation using nanotech scaffolds has been done very successfully with some patients showing remission of diabetes. While this is not a widespread practice yet and it is in trials, it is certainly very promising.

I am a disabled veteran. Like many vets, I am suffering from a complex and chronic illness that largely does not respond to traditional medicine. There are many facets of this illness nanotech may be able to help - I will mention one.

Part of this illness has impacted my vision - I'm guessing here but there seems to be a degenerative process at work in both eyes. Because of this, I have *seen* a marked increase in floaters - so much so that my vision is oft obstructed.

It is my understanding that vetrioretinal surgery can be performed to, in many cases, remediate this issue. However, being that I am only in my 30's, I'm a little young for this highly invasive procedure.

When will I have the better, less invasive option of using nanites to excise / disintegrate these floaters and repair any related ocular injury?

Need a guinea-pig? Sign me up!

RedSarc

While I am not familiar with particular research to eliminate floaters, I know that there are many efforts focused on repairing eye injuries caused by combat in the act of military duty using nanotechnology. For example, we have developed a targeted delivery system for stem cells using nanoparticles that demonstrated that it can cure cornea and retina injuries. So, there is hope for the development of technologies thaw will get rid of those annoying floaters!

Thanks for taking the time to do this AMA! I have a few questions

1. As women in a scientific profession, what struggles did you face in your career path? In your opinion, what can be done to get young females to be interested in careers in science? Is there anything you see out on the market now (toys, media, etc.) that you wish you had when you were a child that would have made your pursuit of science more exciting or easier?

2. I've heard about the grey goo scenario, where nanotechnology replicates uncontrollably and causes widespread destruction. How plausible is this theory? Can you explain it?

Squishface09

1. It seems incredible that in the 21st Century we still need to ask, answer and be subjected to discrimination because we are women scientists, but you are very right, being an academic scientist is hard for women. Breaking the glass dealing is tough, especially in the United States, not so much in Europe, actually. I am a mother of three, married to an academic chemist as well. When I was an Assistant Professor, I faced unreal sexism by senior male members of my department (there were only 2 other women then out of close to 30 faculty) who questioned why I was so ambitious and not happy with being a middle-of-the run professor. This and other nonsense questions motivated me even more to work hard to discover and develop new technologies that in the future may help humankind. We need to excite and motivate young girls from K-12 to pursue scientific careers. We need to make sure that they participate in STEM programs and have teachers and scientists that can be their role models from early on. There are some toys now that promote women as scientists. You can buy even Legos that have women scientist and there are toys that are geared to young girls that foster problem solving and help develop engineering skills. Participation in school activities that promote science and engineering is key. My youngest daughter has been in her school's robotics team since middle school and learned how to code and design and built robots early on. She loves it and wants to become an engineer. I should mention that my oldest daughter is an engineer too. As a child I loved science. Most of my family are engineers, so somehow the desire to solve problems through technology is in my genes. I wish I had had more opportunities to learn hands-on science in middle school and high school, that would have been truly wonderful!
2. The grey goo scenario is just for movies. There are so many checks and balances that nanotechnology is subjected to that it is highly improbable that such a scenario could ever happen. A nanodevice that can autoreplicate would never be approved for use.

Have you discovered any solutions for spinal cord injuries that look promising?

sso_1

There is work geared toward developing technologies for spinal cord injury. There is an entire new field, neuroengineering, that is devoted to discover new ways to regenerate neuronal connections and spinal cord regeneration. There are on-going clinical trials with stem cells that show incredible promise for the cure of spinal cord injury.

Do you think this is going to be a huge advancement in the medical field?

TheRulerOfAll101

Definitely, nanotechnology is able to advance the medical field. The nanotechnologies that are discussed here target complications associated with chronic wound, which is a major public health problem.

Is nanotechnology a potential application for destroying antibiotic resistant bacteria, viruses and cancer?

mungbeen

There are several nanomaterials that have intrinsic properties that allow them to target bacteria, viruses, or cancer. Most of these nanomaterials show a high efficiency at nanoscale. As example, the antibacterial efficacy of the Zinc oxide nanoparticles increases with reduction of particle size.

How would such technology deal with infection?

lazylion_ca

Nanotechnology can provide sustained delivery of antimicrobials.

Currently I'm learning about nanoparticle synthesis and the application of nanoparticles in things like wound healing in undergrad and I was wondering if this was similar. I read the article but didn't see a lot of mention of nanoparticles specifically. Thanks for your research!

realhomeless

Yes that is the same concept. We didn't go into the detailed synthesis of each nanomaterial in this article. We concentrated on the newly developed nanomaterials and how they can target chronic wounds.

Hey there! As a Med Student I wanted to ask you , how do you prevent the immune system from targeting this treatment? As a regular guy, will there be a time in which this applied nanotechnology will be available for the budget of the general public? Thanks for your time!

TedMed14

Nanomaterials are at really small scale to an extent where the immune system does not recognize them. There is always a ongoing research to investigate nanomaterials that are inexpensive and efficient in the same time, which means that the actual nanotechnologies are not expensive especially when used at low amount. What is actually costly is the research that is done prior to the commercialization of nanotechnologies, hence it is important to have governmental funds that cover the research expenses.

Miami grad here! Glad to see the U represented on Reddit.

My question: Do you think any of the techniques you're using to address chronic wounds can be applied to more immediately-lethal wounds?

carolina_cane

Go canes! The answer is yes. For example, there is a great effort in developing nanotechnologies that can help soldier injured in the battlefield. Other research is geared toward finding nanotechnologies that can help individuals who suffer from a traumatic brain injury that can lead to brain death. There are many such examples that aim at the targeted delivery of therapeutic agents that can have an immediate positive effect on an individual and prevent death.

Great topic, thanks for taking the time to answer our questions.

How about starting with the basics? How does nanotechnology work? And why should we care about / invest in this technology? Thanks

ghani1981

Nanotechnology is a field that is based on the production and applications of systems at the nanometer scale (below 100 nm).

We should definitely care about this field because it studies materials with interesting and unique properties that are usually different from their bulk materials. This is so important for biological applications since the nanomaterials of interest have efficient pharmacokinetic properties and several investigated nanosystems are useful fro delivery of therapeutic agents.

Hi.

Thank you for the work you are doing!

I am a Pediatrics Resident, From the exposure you have in this area, how close are we to "dealing" with Diabetes Melliuts Type I (Auto-immune mediated destruction) and is there any promising advancement in that field? I am aware of the Artificial pancreas, and it seems to be a good step in the right direction, however I was wondering about long-term transplant of sorts for the subject. Thanks.

xcuzx

We are very close. As you mentioned, there are examples of transplants of islet nestled in biological scaffolds and even now delivery of stem cells to the pancreas that have proven to be very effective and essentially cure or help quite effectively patients with Type I Diabetes. The examples that I am aware of are in adults, but it is a step in the right direction and eventually could be translated to the peds population.

Wound care RN here, so excited when I saw this AMA! I have a couple questions to ask about this exciting branch of medical technology and your work!

Recently I was in Georgia working with my colleagues at Emory University, which has the program considered the gold standard for training of Wound Care Nurses--the front line of chronic wound care. Have you ever worked with any of those ladies (specifically Dorothy Doughty-- my hero), or considered wrangling them into your work for clinical trials/chronic wound healing insight/issues on the hospital level? They have DECADES of experience in refractory healing and would LOVE to work with all of you, I guarantee it. AND they are conveniently located down the street from the CDC!

Secondly, what sorts of applications are we looking at being produced here and how long before there's general access to any of this (have in vivo trials started)? Is this more along the lines of a specialized dressing impregnated with nanotech or structural help like a superficial growth factor, or a cream/gel like collagen?

One more since I can't help myself: what is your research showing is going on at a cellular level to help the body "reboot" healing of a chronic wound? Any credibility to electrical activity playing a role in the process?

Please feel free to PM me if there's interest to get in contact with the program at Emory--you seriously need to meet Dorothy, she's one of the key founders of wound care as a specialty and though she "retired" she still trains every new WOC nurse and regularly works at the university hospital!

TheMarkHasBeenMade

Thank you so much for your wonderful comments. We will certainly consider your great suggestion of reaching out to Dorothy Doughty at Emory once we are a bit more ready and are approved to perform clinical trials or use in the clinic. In terms of how we envision that our technology will be produced and packaged, all of the options you describe are valid, and basically the ones we have thought about. In addition, our nanocarriers can be delivered systemically to home/target only the locations in the body that exhibit injury and inflammation. This is possible because the epithelial and endothelial cells in the wound overexposes certain receptors and ligands that we can use to target with molecules capable of recognizing them. Once they arrive to the wounded area, the nanocarriers park there and deliver the stem cells or other therapeutic agents that they may be carrying for the healing process to begin. At the cellular levels we know that the stem cells delivered have anti-inflammatory properties, which in turn regulates the expression of cytokines and other molecules involved in the healing process, thus promoting the repair and regeneration of the tissue. You can read more in our ACS Central Science paper, see link above in the Intro of the Reddit and then PLOS ONE paper: PLOS ONE, Apr 22;11(4):e0154053, 2016. doi: 10.1371/journal.pone.0154053. eCollection 2016