

International Conference on Biofabrication

**BIOFABRICATION**



**2019 COLUMBUS**

# FINAL PROGRAM

October 20–22, 2019

Ohio Union, The Ohio State University  
Columbus, Ohio, USA



[biofabrication2019.org](http://biofabrication2019.org)

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## ISBF PRESIDENT'S MESSAGE

With enormous joy and excitement, I would like to welcome you to Columbus, Ohio!

This year marks the 10th anniversary of ISBF, and no one had ever imagined the rapid growth of the society or the explosive expansion of the field we are witnessing currently. I want to take this opportunity to thank the society's founding members, past presidents, and board members for laying the foundations for ISBF and the field to further grow and prosper.

Since the establishment of ISBF, the annual Biofabrication Conference has been the society's major forum where a distinguished group of leaders, scholars, clinicians, regulatory specialists and industry representatives from around the world gathers to exchange innovative ideas, share discoveries, and educate young scientists through a variety of special scientific, social and networking activities crucial to shaping the next-generation of leaders in this field.

Following the successful outcome of the Biofabrication Conference in Wurzburg last year, the 2019 Conference continues to provide stimulating scientific and social programs at all levels in the heart of The Ohio State University. I thank David Dean and his organizing team for their dedication and commitment to putting together an incredible program and activities this year. We recognize that this would not be possible without the participation of everyone attending this conference including ISBF members who could not be here with us. I would like to express my sincere appreciation to all Participants, Plenary and Keynote Speakers, and Session Chairs for their support and contributions toward making this an enlivening and stimulating conference. Finally, special thanks to our Conference Sponsors, Exhibitors, Endorsing Organizations, and Supporters for all their support and critical participation.



I hope you will enjoy the stimulating environment of science, networking and socializing, as well as lasting memories from your time in Columbus, Ohio.

Sincerely,

A handwritten signature in black ink, appearing to read 'J. Yoo', with a long horizontal flourish extending to the right.

**James J. Yoo, MD, Ph.D.**  
President of the International Society for  
Biofabrication (ISBF)

# CONFERENCE CHAIR'S MESSAGE

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## DEAR BIOFABRICATION 2019 ATTENDEE,

It is with great appreciation that I welcome you to Biofabrication 2019 at The Ohio State University. Founded as a land grant university, Ohio State is celebrating its 150th anniversary this academic year.

Our history is forever linked to the Morrill Act, or the Land-Grant College Act, signed into law by President Abraham Lincoln on July 2, 1862, during the middle of the American Civil War. Who would have thought back then that so many famous innovators would be raised and prosper in the Buckeye State! These innovators include Charles Goodyear (vulcanized rubber), Thomas Edison (light bulb, sound recording, motion pictures, and so much more), Albert Michelson and Edward Morley (speed of light), Orville and Wilbur Wright (airplane), George Crile (blood transfusion), Charles Brush (founder of General Electric), Harvey Cushing (early neurosurgeon), and Frank Lauterbur (MRI). Why in Ohio? Those of you from Ohio already know the answer and those visiting Ohio for the first time will soon learn it. It is a constant search for new ideas and the joy of discovery that provides an environment in which so many innovators have and continue to thrive.

It is that innovative spirit that I hope you take away from this conference and maybe an actual prize if you know Ohio trivia. I will be quizzing you on Ohio, Ohio State, and Ohio inventor trivia at the Gala Dinner at the Columbus Museum of Art Tuesday night. Please be sure to pick up one of the available tickets so you don't miss this engaging event.

However, I have not forgotten that the main reason you are here, at the third-largest public university in the United States, is to learn from and contribute to discussion of the current state-of-the-art research in, and clinical translation of, the field of biofabrication. This year's conference highlights your tremendous achievements with sessions on bioinks, on-chip models, cancer therapies, and the regeneration of tissues and organs, including gut, liver, kidney, vasculature, heart, bone, muscle, cartilage, nerve, and brain. We also have two separately ticketed workshops, one on "Bioprinting of Tissue Models for Drug Discovery" (Sunday morning) and a second on the "U.S. Federal Funding Landscape for Bioprinting and the Power of ARMI" (Monday evening). Students and Postdoctoral Researchers will also have the opportunity to attend three Young Scientist Forum events. All are welcome at the many networking receptions, including two poster sessions and the opening night reception at the Blackwell Inn.



I hope you enjoy your time at Ohio State. As you take in the wealth of inspiration occurring in the heart of innovation country, please remember that you are all, now and forever more, honorary Buckeyes!

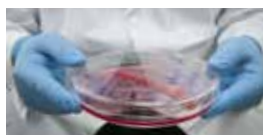
Sincerely,

A handwritten signature in black ink, appearing to read "D. Dean".

**David Dean, Ph.D.**  
Conference Chair, Biofabrication 2019

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- ▶ More than 14 treatments have reached the clinical testing stage—and many others are in the pipeline.



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# CONFERENCE ORGANIZERS

## GREETINGS FROM THE ORGANIZERS

### Local Steering Committee

- **David Dean**, Ph.D., Conference Chair, The Ohio State University, USA
- **Ed Herderick**, Ph.D., Industry Chair, The Ohio State University, USA
- **Ciro Rodriguez**, Program Chair, The Ohio State University, USA / Tecnologico de Monterrey, Mexico
- **Aleksander Skardal**, Ph.D., The Ohio State University, USA
- **Matt Schutte**, The Ohio State University, USA
- **Steve Ringel**, Ph.D., The Ohio State University, USA
- **Nate Ames**, MS, The Ohio State University, USA
- **John F. Lewis, Jr**, JD, BioOhio, USA

### Program Committee

- **Ciro Rodriguez**, Ph.D., Program Chair, The Ohio State University, USA / Tecnologico de Monterrey, Mexico

### Scientific Advisory Board

- **Mark Allenby**, Ph.D., Herston Biofabrication Institute, Queensland University of Technology, Australia
- **Mario Alvarez**, Ph.D., Centro de Biotecnologia FEMSA, Tecnologico de Monterrey, Mexico
- **Alberto Caballero**, Ph.D., National Laboratory for Additive and Digital Manufacturing (MADIT), Universidad Nacional Autonoma de Mexico, Mexico
- **Hector A. Cabrera-Fuentes**, Ph.D., National Heart Research Institute, Singapore
- **Marco Domingos**, Ph.D., School of Mechanical, Aerospace and Civil Engineering, The University of Manchester, UK

- **Lakshmi Prasad Dasi**, Ph.D., Department of Biomedical Engineering, The Ohio State University, USA
- **Natalia Higuaita-Castro**, Ph.D., Department of Surgery, The Ohio State University, USA
- **Yahya E. Choonara**, Ph.D., Department of Pharmacy and Pharmacology, University of the Witwatersrand, South Africa
- **Akhilesh K. Gaharwar**, Ph.D., Department of Biomedical Engineering, Texas A&M University, USA
- **Daniel Gallego-Perez**, Ph.D., Department of Surgery, The Ohio State University, USA
- **Paola Ginestra**, Ph.D., Department of Mechanical and Industrial Engineering, University of Brescia, Italy
- **Jan A. Lammel-Lindemann**, M.D., Ph.D., Department of Surgery, Houston Methodist Hospital, USA
- **Moo-Yeal Lee**, Ph.D., Department of Chemical & Biomedical Engineering, Cleveland State University, USA
- **Khoon Lim**, Ph.D., Department of Orthopaedic Surgery, Centre for Bioengineering & Nanomedicine, University of Otago Christchurch, New Zealand
- **Gabriella Lindberg**, Ph.D., Department of Orthopaedic Surgery, Centre for Bioengineering & Nanomedicine, University of Otago Christchurch, New Zealand
- **Nicanor I. Moldovan**, Ph.D., Departments of Biomedical Engineering & Ophthalmology, Indiana University-Purdue University at Indianapolis, USA

# CONFERENCE ORGANIZERS

- **Edgar B. Montufar**, Ph.D., Central European Institute of Technology, Brno University of Technology, Czech Republic
- **Ibrahim Tarik Ozbolat**, Ph.D., Department of Engineering Science and Mechanics, Penn State University, USA
- **David Prawel**, Ph.D., Department of Mechanical Engineering, Colorado State University, USA
- **Leopoldo Ruiz**, Ph.D., National Laboratory for Additive and Digital Manufacturing (MADIT), Universidad Nacional Autonoma de Mexico, Mexico
- **Laura Ruiz-Cantu**, B.D.S., Ph.D., Centre for Additive Manufacturing, University of Nottingham, UK
- **Dhvanit I. Shah**, Ph.D., Center for Childhood Cancers and Blood Diseases, Nationwide Children's Hospital, USA
- **Tolou Shokuhfar**, Ph.D., Department of Bioengineering, University of Illinois at Chicago, USA
- **Aleksander Skardal**, Ph.D., Department of Biomedical Engineering, The Ohio State University, USA
- **Lester Smith**, Ph.D., 3D Bioprinting Core, Radiology and Imaging Sciences, Indiana University, USA
- **Katelyn E. Swindle-Reilly**, Ph.D., Department of Biomedical Engineering, The Ohio State University, USA
- **Alok Sutradhar**, Ph.D., Department of Mechanical and Aerospace Engineering, The Ohio State University, USA
- **Grissel Trujillo**, Ph.D., Centro de Biotecnologia FEMSA, Tecnologico de Monterrey, Mexico
- **Jason Walker**, Ph.D., Mechanical, Industrial and Manufacturing Engineering, Youngstown State University, USA
- **Qinghua Wu**, Ph.D., Department of Chemical Engineering & Applied Chemistry, University of Toronto, Canada
- **Xu Zhang**, Ph.D., Center for Design and Manufacturing Excellence (CDME), The Ohio State University, USA

## ISBF Awards Committee

- **David Dean**, Ph.D., Chair, The Ohio State University, USA
- **Giovanni Vozzi**, Ph.D., University of Pisa, Italy
- **Paul Dalton**, Ph.D., University of Wurzburg, Germany
- **Utkan Demirci**, Ph.D., Stanford University, USA
- **Sang Jin Lee**, Ph.D., Wake Forest School of Medicine, USA
- **Roger Narayan**, Ph.D., University of North Carolina School of Medicine, USA

## Student Committee

- **Patrick Smith**, Biomedical Engineering, CDME, Chair
- **Maxwell Williams**, Data Analytics, Mobile App Leader
- **Jan Lammel-Lindemann**, Plastic & Reconstructive Surgery
- **Raquel Tejada**, Plastic & Reconstructive Surgery
- **Agnieszka Chmielewska**, Plastic & Reconstructive Surgery
- **Katie Bradshaw**, Biological Engineering, CDME
- **Cassie Crisp**, Marketing & Communications, CDME
- **Carlos Andres Rodriguez**, Computer Science & Engineering

# REGISTRATION

Your registration badge ensures admission to standard conference events. All standard, postdoctoral researcher, and graduate student registrants receive access to the following:

- Plenary sessions and trade show
- Technical breakout sessions
- International Society for Biofabrication annual membership dues
- Sunday evening welcome reception
- Coffee breaks
- Shuttle transportation to/from conference hotel nodes and conference venue
- Sunday and Monday poster sessions and receptions
- Laboratory tours

*Note: Some activities require separate ticketing.*

## Registration fees do not include:

- Access to Tuesday's Conference Champagne Reception and Gala Dinner
- Accompanying person tour
- Access to workshops

## Registration is available in the following categories:

- **Full-Conference:** \$775. Includes technical breakout session access.
- **Graduate Students and Postdoctoral Researchers:** \$450. Includes technical breakout session access. *A copy of a valid student school identification card must accompany form to receive student rates.*
- **Full-Conference Daily (one day only):** \$375. Includes technical breakout sessions access for Sunday, Monday, **or** Tuesday.
- **Accompanying Person, Trade Show and Social:** \$275. Does **not** include technical breakout session access. Includes: plenary sessions, trade show, poster sessions, Sunday evening welcome reception, lunch on Monday and Tuesday, coffee breaks, shuttle transportation to/from conference hotels and conference venue, laboratory tours, and access to separately ticketed tours.

## Registration Hours

The registration desk will be located at the Ohio Union, first floor, in the Great Hall Meeting Room at the following times:

Sunday, October 20: 9:00 a.m.–6:30 p.m.  
Monday, October 21: 7:30 a.m.–5:30 p.m.  
Tuesday, October 22: 7:30 a.m.–5:30 p.m.

## Exhibition Hours

*The exhibition will be in the West Ballroom on the second floor of the Ohio Union.*

### Exhibitor set-up

Sunday, October 20: 8:00 a.m.–12:00 p.m.

### Exhibits

Sunday, October 20: 1:00 p.m.–4:30 p.m.  
Monday, October 21: 9:00 a.m.–1:00 p.m.;  
2:00 p.m.–5:30 p.m.  
Tuesday, October 22: 9:00 a.m.–1:00 p.m.;  
2:00 p.m.–4:30 p.m.



# ABOUT THE VENUE



THE OHIO STATE  
UNIVERSITY

The Ohio State University is pleased to host Biofabrication 2019 in Columbus, Ohio. Many of the events will be at the **Ohio Union**, located on campus at 1739 High St., Columbus, Ohio 43210. Presentation rooms on the ground floor will be the Great Hall Meeting Room, Great Hall Lobby, Great Hall Art Gallery, Performance Hall, and U.S. Bank Conference Theater and on the second floor will be the Archie Griffin Ballroom and the West Ballroom. As a landmark facility honoring university tradition, the Ohio Union provides a welcoming environment for the community and guests.



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# AMENITIES & MEETING APP

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## Complimentary Wi-Fi Internet Access

Use the following instructions to connect:

1. From your device's wireless connection utility, choose to connect to "WiFi@OSU". No password is required.
2. After waiting a few seconds to establish a connection, open a web browser. Most devices will automatically be redirected to an authentication page. If this does not occur within 30 seconds of opening your browser, type [www.osu.edu](http://www.osu.edu) into the browser's address bar.
3. Upon reaching the authentication page and reviewing the terms and conditions, check the box under the Guests column and click Log-in.

## Language

The official conference language is English. No simultaneous translation is provided.

## Speaker Ready Room

Speakers should upload their presentations 24 hours prior to their session. Instructions will be provided by email. There will be computers available for reviewing and preparing presentations. They may edit their presentations after the initial upload, if changes need to be made prior to their session.

## Posters

Poster presentations will be held in the Performance Hall. Posters should be set up prior to the poster session on October 20 at 4:30 p.m. Presenting authors have been assigned a poster number and must be present during their allotted time, which is the first half-hour for even-numbered posters and the second half-hour for odd-numbered posters on Day 1. Judges will only visit selected posters. It is optional for authors to stand by the posters on the second day. First through third place Biofabrication (IOP) Best Poster Awards will be announced at the Closing Ceremony.

## Approved Literature Table and Job Board

Attendees and peer organizations may place company information, job postings, social flyers, or other printed items appropriate for the conference audience at their booths or at the Approved Literature Table in the Exhibition Hall. A job posting board is also at this table.

## Meeting App for Android and iOS



"CrowdCompass AttendeeHub" will help you navigate the conference! Go to [go.osu.edu/BioFabAndroid](http://go.osu.edu/BioFabAndroid) or [go.osu.edu/BioFabiOS](http://go.osu.edu/BioFabiOS) to download the app for your device.

In the app, search for "Ohio State Biofab" to find our conference's information. Follow along with the event schedule, learn about our sponsors, network with attendees, upload your bio, and navigate the campus with maps on your phone.

# AMENITIES & MEETING APP

## Amenities Located in the Ohio Union

Gender-neutral restrooms are on the south wall on the first and third floors near the elevator. A lactation room is on the south wall on the second floor near the elevator. Meditation/ablution spaces are in the vestibules of the Interfaith Prayer and Reflection Room on the third floor. Water bottle refill stations are located on the south wall of the first floor and in the Union Market.

## Print Services

UniPrint is located at 1598 North High Street, Columbus, OH 43201. Closed Sundays. For details: [uniprint.osu.edu](http://uniprint.osu.edu).

## Dining Options

The Ohio Union houses four dining options on the ground floor, including The Union Market, Sloopy's Diner, Woody's Tavern, and Espresso-OH.

## Parking

Parking, managed by CampusParc, is available in the parking garage adjacent to the Ohio Union. Please follow signs to park in the Ohio Union South Garage, 1759 North High Street. For more information, visit: [osu.campusparc.com](http://osu.campusparc.com).

## Blackwell Inn

This hotel is a walk of just under one mile through the heart of campus to the conference venue. The campus bus system stops outside the hotel (the Knowlton Hall stop). Download the OSU CABS app to see the campus bus schedule. Campus buses run Monday through Friday only.



# Biofabrication

[iopscience.org/bf](http://iopscience.org/bf)

## Editor-in-Chief

**Wei Sun** Drexel University, Philadelphia, PA, USA,  
and Tsinghua University, China

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*Biofabrication*<sup>™</sup> focuses on cutting-edge research on the use of cells, proteins, biological materials and biomaterials as building blocks to manufacture biological systems and therapeutic products. *Biofabrication* is the **official journal of the International Society for Biofabrication**.



Visit [iopscience.org/bf](http://iopscience.org/bf) for more information.

Image: SEM image of cardiac cells (purple) starting to form cell-matrix interactions within omentum-based scaffolds  
Michal Shevach et al 2014 *Biofabrication* 6 024101





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# ISBF & WFIRM AWARDS

*Biofabrication (IOP) first, second, and third place poster awards will be announced at the meeting. Judging will be Sunday, Oct 20, 4:30 p.m.–5:30 p.m. Even numbers are to stand by their poster for the first half hour, and odd numbers for the second half hour.*

The International Society for Biofabrication (ISBF) and Wake Forest Institute for Regenerative Medicine (WFIRM) celebrate the 2019 award winners for achieving excellence in the field of biofabrication.

## Senior Investigator Award – Biofabrication 2019

The purpose of the ISBF's Senior Investigator Award is to recognize a senior investigator who has made significant scientific contributions to the field of biofabrication.

- **Dong-Woo Cho**, Ph.D., Department of Mechanical Engineering at Pohang University of Science and Technology Pohang, South Korea

## Mid-Career Investigator Award – Biofabrication 2019

The purpose of the ISBF's Mid-Career Investigator Award is to recognize a mid-career investigator who has made significant scientific contributions to the field of biofabrication.

- **Ferry Melchels**, Ph.D., Institute of Biological Chemistry, Biophysics and Bioengineering, Heriot-Watt University, Edinburgh, United Kingdom

## ISBF Young Investigator Awards – Biofabrication 2019

The purpose of the ISBF's Young Investigator awards is to recognize outstanding achievements by members of the ISBF who are in the early stages of a career in the field of biofabrication.

- **Gabriella C.J. Lindberg**, Ph.D., Department of Orthopaedic Surgery, University of Otago, Christchurch, New Zealand
- **Jihoon Park**, Ph.D., Wake Forest Institute of Regenerative Medicine, Wake Forest School of Medicine, Winston Salem, North Carolina, USA
- **Ashkan Shaflee**, Ph.D., Wake Forest Institute of Regenerative Medicine, Wake Forest School of Medicine, Winston Salem, North Carolina, USA

## WFIRM Young Investigators Award - Biofabrication 2019

The Wake Forest Institute for Regenerative Medicine is committed to the development and dissemination of novel therapies for the repair and replacement of diseased tissues and organs. One way to achieve this goal is to foster the careers of young investigators to encourage them to find solutions to problems in regenerative medicine.

- **Saigopalakrishna S. Yermeni**, Department of Biomedical Engineering, Carnegie Mellon University, Pittsburgh, Pennsylvania, USA



# ISBF & WFIRM AWARDS

## ISBF Travel Awards - Biofabrication 2019

The purpose of the ISBF's Travel Awards is to foster the careers of students and trainees in the field of biofabrication by encouraging them to participate in the 2018 Biofabrication Conference to further develop their scientific minds, interact with other scientists in the field, establish networking and refine their presentation skills.

- **Jonna Babilotte**, Université de Bordeaux, Bordeaux, France
- **Irene Chiesa**, University of Pisa, Pisa, Italy
- **Manuella Estermann**, Adolphe Merkle Institute, Fribourg, Switzerland
- **Benjamin Kessel**, ETH Zurich, Zurich, Switzerland
- **Jinyang Li**, University of Maryland, College Park, MD, USA
- **Jihoon Park**, Ph.D., Wake Forest School of Medicine, Winston-Salem, NC, USA
- **Jannika T. Paulamki**, University of Bergen, Bergen, Norway
- **Anne Metje van Genderen**, Utrecht University, Utrecht The Netherlands

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# PLENARY SPEAKERS

Archie Griffin Ballroom, Ohio Union, OSU Campus



- **Jos Malda**, Utrecht University, the Netherlands  
Sunday, 1:00 p.m. - Presentation Title: *Convergence of Technologies: The Next Step in Biofabrication*



- **Jennifer Lewis**, Harvard University, USA  
Monday, 8:00 a.m. - Presentation Title: *Biomanufacturing of Organ-Specific Tissues with Embedded Vasculature*



- **Anthony Atala**, Wake Forest School of Medicine, USA  
Monday, 1:00 p.m. - Presentation Title: *Regenerative Medicine: Current Concepts and Changing Trends*



- **Wei Sun**, Drexel University, USA  
Tuesday, 8:00 a.m. - Presentation Title: *Biofabrication for In Vitro Tissue Engineering*



- **Ali Khademhosseini**, University of California, Los Angeles, USA  
Tuesday, 1:00 p.m. - Presentation Title: *Nano- and Microfabricated Hydrogels for Regenerative Engineering*



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AT THE OHIO STATE UNIVERSITY



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IMR supports, promotes and facilitates research and infrastructure related to the science and engineering of materials. IMR supports and advances fundamental and applied materials-allied research by cultivating interdisciplinary teams across multiple colleges, identifying strategic funding and partnership opportunities, and supporting the creation of large research centers. IMR enables long-term, mutually beneficial innovation partnerships between industry partners and students, faculty and staff. IMR fosters a collaborative ecosystem at Ohio State, with a community of more than 260 faculty members from 40 departments in 10 colleges.

## Research support

IMR supports materials-allied research at Ohio State through multiple grant and grant proposal resources. These opportunities enable investigators to advance collaborative, consequential research.

## Research facilities

IMR operates and supports a diverse collection of shared core research facilities that allow the materials community at Ohio State to carry out state-of-the-art research while providing world-class educational experiences to students.

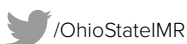
## Research and Innovation

Mutually beneficial partnerships between industry and academia are integral to IMR. The institute stimulates engagement with companies and develops workshops and programs with organizations in the U.S. and abroad. The Innovation Lab advances community well-being through the creation and dissemination of translational knowledge to solve the world's most pressing problems in the 21st century.



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# KEYNOTE SPEAKERS



- **Session 01 - Bioinks 1.** "KEYNOTE - Synthetic building blocks for injectable regenerative materials" by **Laura De Laporte**, Leibniz Institute for Interactive Materials, Germany



- **Session 02 - Liver.** "KEYNOTE - 3D Bioprinting of In Vitro Metastatic Cancer Models" by **Angela Panoskaltzis-Mortari**, University of Minnesota, USA



- **Session 03 - Design, Simulation & Monitoring.** "KEYNOTE - A Multifunctional DNA-origami platform for Biomolecular Detection in Cellular Microenvironments" by **Carlos Castro**, The Ohio State University, USA



- **Session 04 - Musculoskeletal 1.** "KEYNOTE - 3D Printing with Living Cells" by **Gordon Wallace**, University of Wollongong, Australia



- **Session 05 - Bioinks 2 & Kidney.** "KEYNOTE - Expanding the Biomaterial Toolbox for Biofabrication: From Development to Commercialization" by **Ramille Shah**, University of Illinois at Chicago, USA



- **Session 06 - Gastro 1.** "KEYNOTE - Mapping the ovarian matrisome to better inform an engineered bioprosthetic ovary" by **Monica M. Laronda**, Northwestern University, USA



- **Session 07 - Musculoskeletal 2.** "KEYNOTE - Advanced Biofabrication Methods for Large Cartilage Organs" by **Marcy Zenobi-Wong**, ETH Zurich, Switzerland



- **Session 08 - Brain & Neuro.** "KEYNOTE - Emulsion Inks for 3D Printing of Tissue Engineering Scaffolds" by **Elizabeth Cosgriff-Hernandez**, University of Texas at Austin, USA



- **Session 09 - Gastro 2.** "KEYNOTE - Differentiation of pluripotent stem cells towards nephron progenitor cells for bioprinted renal in vitro model" by **Carlos Mota**, Maastricht University, The Netherlands



- **Session 10 - Novel Processing 1.** "KEYNOTE - Bioprinting Scaffolds for Tissue Engineering Applications" by **Daniel Chen**, University of Saskatchewan, Canada



- **Session 11 - Cardio & Vascular 1.** "KEYNOTE - Stromal cells promote neovascular invasion across tissue interfaces" by **Hannah Strobel**, Advanced Solutions Life Sciences, USA

# KEYNOTE SPEAKERS



- **Session 12 - Musculoskeletal 3.** "KEYNOTE - Combination of smart and biodegradable materials and biofabrication techniques for the treatment of osteoporotic fractures: the challenge of GIOTTO project" by **Giovanni Vozzi**, Università di Pisa, Italy



- **Session 13 - Novel Processing 2 & On-Chip Applications.** "KEYNOTE - Convergence of Biofabrication and Microphysiological Organ-on-a-Chip Technologies for High Throughput Screening" by **Tim Woodfield**, University of Otago, New Zealand



- **Session 14 - Cardio & Vascular 2.** "KEYNOTE - Biofabrication of tubular grafts via melt electrowriting and combined approaches" by **Tomasz Jüngst**, University of Würzburg, Germany



- **Session 15 - Cancer & Regulatory.** "KEYNOTE - The Use of Thermal Inkjet Printed Cell Activation for Tissue Engineering and Cancer Models" by **Thomas Boland**, University of Texas at El Paso, USA



- **Session 15 - Cancer & Regulatory.** "KEYNOTE - Drawing Creatively within the Lines: Regulatory Approaches for Emerging Regenerative Medicine Therapies" by **Richard McFarland**, ARMI/BioFabUSA, USA

**April 20-23, 2020**

**Anaheim (CA) Convention Center**



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# SESSION CHAIRS

---

- **Session 01 - Bioinks 1**  
**Laura Ruiz-Cantu**, University of Nottingham, United Kingdom
- **Session 02 - Liver**  
**Thomas Boland**, University of Texas at El Paso, USA
- **Session 03 - Design, Simulation & Monitoring**  
**Lester J. Smith**, Indiana University, USA
- **Session 04 - Musculoskeletal 1**  
**Gabriella Lindberg**, University of Otago, New Zealand
- **Session 05 - Bioinks 2 & Kidney**  
**Luiz Henrique Catalani**, University of Sao Paul, Brazil
- **Session 06 - Gastro 1**  
**Brian Derby**, University of Manchester, United Kingdom
- **Session 07 - Musculoskeletal 2**  
**Grissel Trujillo**, Tecnologico de Monterrey, Mexico
- **Session 08 - Brain & Neuro**  
**Gabor Forgacs**, University of Missouri, USA
- **Session 09 - Gastro 2**  
**Marcy Zenobi-Wong**, ETH Zurich, Switzerland
- **Session 10 - Novel Processing 1**  
**Heather Powell**, The Ohio State University, USA
- **Session 11 - Cardio & Vascular 1**  
**Hector A. Cabrera-Fuentes**, National Heart Research Institute, Singapore
- **Session 12 - Musculoskeletal 3**  
**Michael Gelinsky**, TU Dresden, Germany
- **Session 13 - Novel Processing 2 & On-Chip applications**  
**Bahattin Koc**, Sabanci University, Turkey
- **Session 14 - Cardio & Vascular 2**  
**Hannah Strobel**, Advanced Solutions Life Sciences, USA
- **Session 15 - Cancer & Regulatory**  
**Monica M. Laronda**, Northwestern University, USA and **Richard McFarland**, BioFabUSA, USA

# SPECIAL EVENTS

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## Champagne Reception and Gala Dinner

Tuesday, October 22

Reception: 7:00 p.m.–8:00 p.m.

Dinner: 8:00 p.m.–11:00 p.m.

Columbus Museum of Art, 480 East Broad St., Columbus, Ohio 43215



## Poster Sessions:

Sunday, October 20, 4:30 p.m.–6:30 p.m.

Monday, October 21, 4:30 p.m.–6:30 p.m.

Performance Hall, Ground Level,

Ohio Union, OSU Campus, 1739 North High St.,

Columbus, OH 43210



# SPECIAL EVENTS



## **Opening Conference Reception:**

Sunday, October 20, 7:00 p.m.–9:30 p.m.  
The Blackwell Hotel, OSU Campus,  
2110 Tuttle Park Pl, Columbus, OH 43210



## **Awards & Closing Ceremony:**

Tuesday, October 22, 4:30p.m.–5:30 p.m.  
Archie Griffin Ballroom, Second Floor  
Ohio Union, OSU Campus

## **Editorial Board Meeting (private)**

Sunday, October 20, 7:30 a.m.–8:00 a.m. breakfast; 8:00 a.m.–9:15 a.m. meeting  
Pfahl Hall Room, 202, The Blackwell Hotel, OSU Campus

## **Board of Director Meeting (private)**

Sunday, October 20, 8:45 a.m.–9:30 a.m. breakfast, 9:30 a.m.–11:30 a.m. meeting  
Pfahl Hall Room, 202, The Blackwell Hotel, OSU Campus

## **Workshops**

- **Workshop: 3D Bioprinting of Tissue Models for Drug Discovery**, Sunday, October 20, 9:30 a.m.–11:30 a.m., Performance Hall, Ohio Union, OSU Campus
- **Workshop: The Federal Funding Landscape for Biofabrication Research and Commercialization and the Power of ARMI**, Monday, October 21, 6:30 p.m.–8:30 p.m., Performance Hall, Ohio Union, OSU Campus

## **Young Scientists Forum**

YSF is for individuals in the early stages of their research careers—graduate students and post-doctoral fellows. The following YSF activities are planned:

- **Meet the Editor**: Monday, October 21, 11:30 a.m.–1:00 p.m., Performance Hall, Ohio Union, OSU Campus
- **YSF Reception**: Monday, October 21, 7:30 p.m.–10:00 p.m., Chumley's, 1516 N. High Street, Columbus, OH 43201.
- **Meet the Legends**: Tuesday, October 22, 11:30 a.m.–1:00 p.m., Performance Hall, Ohio Union, OSU Campus

## **University of Wollongong Reception**

Tuesday, October 22, 5:30 pm.–6:30 p.m.,  
Archie Griffin Ballroom West, Ohio Union, OSU Campus

# CONVOCATION

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**Sunday, 12:00 p.m.–1:00 p.m.,**  
**Archie Griffin Ballroom, Second Floor, Ohio Union, OSU Campus**

## **Speakers:**

- **David Dean**, Ph.D., Biofabrication 2019 Conference Chair, Associate Professor, Materials Science & Engineering and Plastic & Reconstructive Surgery; (bio: <http://osteoenengineering.com/team/DavidDean>)
- **David B. Williams**, Ph.D., Monte Ahuja Dean's Chair, Dean and Professor in Materials Science & Engineering, College of Engineering (bio: <https://engineering.osu.edu/about/dean>)
- **K. Craig Kent**, M.D., Leslie H. and Abigail S. Wexner Dean's Chair in Medicine, VP for Health Sciences, Dean and Professor, College of Medicine (bio: <https://wexnermedical.osu.edu/about-us/our-people/k-craig-kent>)
- **David McComb**, Director, Center for Electron Microscopy Analysis (CEMAS), Ohio Resident Scholar and Professor in Materials Science & Engineering; (bio: <https://cemas.osu.edu/people/mccomb.29>)
  - Speaking on behalf of **Steven Ringel**, Ph.D., Director, Institute of Materials Research (IMR), Neal A. Smith Endowed Chair in Electrical Engineering; (bio: <http://www2.ece.ohio-state.edu/~ringel/>; <https://imr.osu.edu/imrs-steven-ringel-awarded-title-of-distinguished-university-professor/>)
- **Nate Ames**, Executive Director, Center for Design and Manufacturing Excellence, Adjunct Research Associate Professor of Materials Science & Engineering; (bio: <https://cdme.osu.edu/people/ames.21>)

**Monday, 7:30 a.m.–8:00 a.m.,**  
**Archie Griffin Ballroom, Second Floor, Ohio Union, OSU Campus**

## **Speakers:**

- **Kenny McDonald**, C.Ec.D., President and Chief Economic Officer, One Columbus; (bio: <https://columbusregion.com/our-team/kenny-mcdonald/>)
- **John F. Lewis, Jr.**, J.D., Director, BioOhio; (bio: <https://www.bioohio.com/about/staff/>)

## Workshop: 3D Bioprinting of Tissue Models for Drug Discovery

**Sunday, October 20, 9:30 a.m.–11:30 a.m., Performance Hall, Ohio Union**

### Organizers:

- **Nicanor I. Moldovan**, Ph.D., Indiana Institute for Medical Research at VA Indianapolis, USA
- **Marc Ferrer**, Ph.D., National Center for Advancing Translational Sciences, USA

### Program:

- **Wei Sun**, Ph.D., Drexel University, USA: "Bioprinting micro-physiological models for drug testing"
- **Thomas Nieland**, Ph.D., Tufts University, USA: "Bioengineered 3-dimensional human models of the CNS for biomarker and drug discovery"
- **Min Jae Song**, Ph.D., NCATS/NIH, USA: "3D Bioprinting of vascularized tissue models for drug discovery"
- **Sharon Presnell**, Ph.D., Amnion Foundation, USA: "Cell sourcing for bioprinted drug discovery assays"
- **Ty Voss**, Ph.D., NIH/NCATS, USA: "High throughput imaging for drug discovery"
- **Marc Thurner**, MimiX Biotherapeutics, Switzerland: "New technology for high throughput in vitro bioprinting."

## Workshop: The Federal Funding Landscape for Biofabrication Research and Commercialization and the Power of ARMI

**Monday, October 21, 6:30 p.m.–8:30 p.m., Performance Hall, Ohio Union**

### Organizers:

- **Lloyd Rose**, PhD, BiofabUSA; Warfighter Expeditionary Medicine & Treatment U.S. Army Medical Materiel Development Activity, Fort Detrick, USA, Session Chair
- **David Dean**, Ph.D., The Ohio State University, USA

### Program:

- **Dobрила Doda Rudnicki**, Ph.D., NCATS-NIH, MD, USA: "NCATS: Catalyzing Development of Human cell-based 3D platforms for drug screening"
- **Lloyd Rose**, Ph.D., BiofabUSA; Warfighter Expeditionary Medicine & Treatment U.S. Army Medical Materiel Development Activity, USA: "DoD Funding Opportunities for Biofabrication and Biomanufacturing"
- **Kelli Blaize-Wise**, The Geneva Foundation, USA: "The Geneva Foundation's Role in Supporting Biofabrication Research for the Advancement of Military Medicine"
- **Chenzhong Li**, Ph.D., National Science Foundation, USA: "NSF Perspectives and Status on Advanced Biomanufacturing and Biomedical Devices Program"



## The Center for Design and Manufacturing Excellence

Biomedical Technology Translation & Innovation | [cdme.osu.edu](http://cdme.osu.edu)

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### What We Do:

- Help researchers and entrepreneurs translate biomedical technologies towards commercialization
- Provide high quality biomedical engineering services to the applied research community and industry
- Build the future biomedical workforce in design, manufacturing and technology innovation

**The Center for Design and Manufacturing Excellence partners with an interconnected, interdisciplinary biomedical community across Ohio State's colleges and centers.**



## VISIT OUR BOOTH

Center for Design and Manufacturing Excellence (CDME)

Mary Hoffman Pancake

Xu Zhang

[pancake.6@osu.edu](mailto:pancake.6@osu.edu)

[zhang.1182@osu.edu](mailto:zhang.1182@osu.edu)

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## Biomaterials

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## Bioprinting/ Biofabrication

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Surgery  
Ophthalmology  
Center for Regenerative Medicine  
and Cell-Based Therapies



## Medical 3D Printing

Mechanical and Aerospace  
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Neurosurgery  
Spine Research Institute



## Medical Device Development

Biomedical, Mechanical, and Aerospace  
Engineering  
Center for Clinical and Translational  
Science  
Center for Regenerative Medicine and  
Cell-Based Therapies  
Wexner Medical Center  
Spine Research Institute- Ergonomics



- CDME is seeking industrial collaborators in biofabrication technology innovation and center development.
- The College of Engineering is actively seeking a post doctoral researcher interested in working at the intersection of robotics, tissue engineering, and technology entrepreneurship. For more information email [hoelzle.1@osu.edu](mailto:hoelzle.1@osu.edu)

# SPONSORS AND EXHIBITORS

The Biofabrication 2019 organizers would like to thank the following Sponsors and Exhibitors for their gracious support of the event:

## FEATURED SPONSOR



## SPONSORS



## ENDORSEMENTS

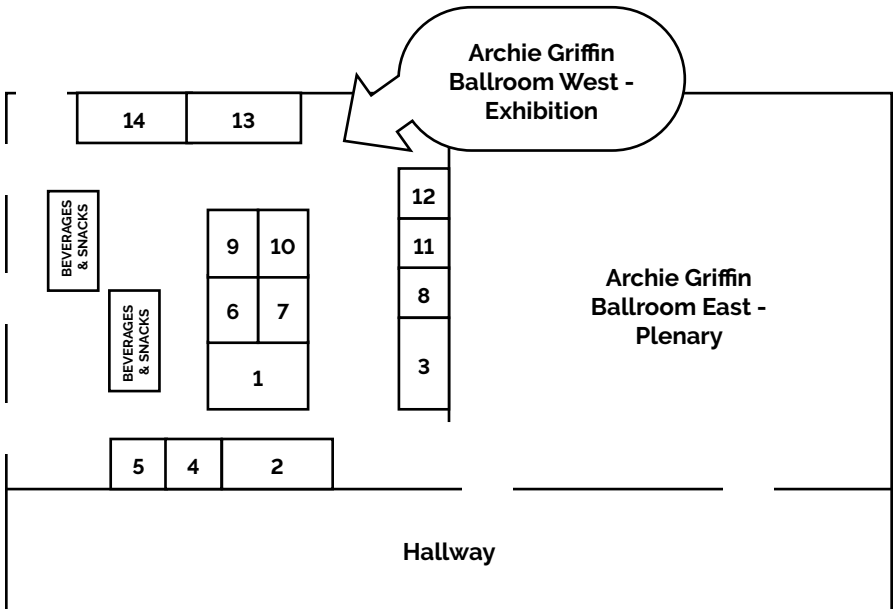


## EXHIBITORS





# EXHIBITION MAP



- |                              |                     |  |
|------------------------------|---------------------|--|
| 1 ..... Cellink              | 6 ..... Biomomentum | 12 ..... SunP Biotech                                |
| 2 .... Advanced Solutions    | 7 ..... EnvisionTEC | 13 ..... Approved Literature/Job Board               |
| Life Sciences                | 8 ..... ROKIT       | 14 ..... Ohio State Univ./ Univ. Wollongong/ BioOhio |
| 3 ..... Biofabrication (IOP) | 9 ..... Zeiss       |  |
| 4. .... Lulzbot              | 10 ..... SITRI      |  |
| 5 ..... Viscus Biologics     | 11 ..... Claro      |  |



A plenary session (pictured left) from the 2018 Biofabrication Conference in Wurzburg, Germany

# MEETING POLICIES

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The organizers of the Biofabrication 2019 event have contracted with TMS to provide conference services for this event.

## BADGES

All attendees must wear registration badges at all times during the congress to ensure admission to events included in the paid fee, such as technical sessions, exhibition, and receptions.

## REFUNDS

The deadline for all refunds was October 7, 2019. No refunds will be issued at the conference. Fees and tickets are nonrefundable.

## PHOTOGRAPHY AND RECORDING POLICY



Biofabrication 2019 reserves the right to all audio and video reproductions of presentations. By registering for this conference, all attendees acknowledge that they may be photographed by Biofabrication 2019 personnel

while at events, and that those photos may be used for promotional purposes, in and on Biofabrication 2019 publications and websites, and on social media sites.

Any recording of presentations or sessions (audio, video, still photography, etc.) intended for personal use, distribution, publication, or copyright without the express written consent of Biofabrication 2019 and the individual authors is strictly prohibited. Attendees violating this policy may be asked to leave the session.

## MOBILE PHONES



In consideration of attendees and presenters, we kindly request that you minimize disturbances by setting all mobile phones and other devices on "silent" while in meeting rooms.

## AMERICANS WITH DISABILITIES ACT



Biofabrication 2019 supports the federal Americans with Disabilities Act (ADA) which prohibits discrimination against, and promotes public accessibility for, those with disabilities. In support of, and in compliance with

ADA, we ask those requiring specific equipment or services to contact [mtgserv@tms.org](mailto:mtgserv@tms.org) in advance.

## DIETARY REQUESTS

Biofabrication 2019 will work with the meeting facility/hotel to meet attendee dietary requests, provided staff is informed of the special request at least 24 hours in advance of the request. Please indicate dietary restrictions when registering.

## TIME ZONES

Unless otherwise noted, all times for this conference and related events will take place in the local time zone (i.e., United States Eastern Daylight Savings Time or UTC -0500).

## CURRENCY

All meeting fees are expressed in U.S. dollars (USD).

# EMERGENCY PROCEDURES

Being prepared to react in an emergency situation is the most critical step in ensuring the health and safety of yourself and those around you. Please take a few moments to review the maps of the Ohio Union printed in this program. When you enter a building, familiarize yourself with the exits and the stairs leading to those exits. When you arrive at your session or event location, look for the emergency exits that are in closest proximity to you.

**In case of a fire, all attendees will be advised to leave the building through the nearest fire exit.**

Please use the following local safety and security contact information if you or someone near you is experiencing an emergency:

- Dial 9-1-1 and let the operator know you are at the Ohio Union on the Ohio State University Campus.
- Report emergencies to our building staff at the Information Center on the ground floor, or by calling the Building Manager at 614-402-4335.
- In case of facility emergency or building evacuation, follow announcements and directions from Ohio Union staff.

## CEMAS

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Our full-service facility – from extensive sample preparation laboratories to image-processing tools and support – allows researchers to carry out their entire microscopy and analysis program at CEMAS. Located in a purpose built facility on The Ohio State University’s West Campus, every instrument in the facility meets or exceeds manufacturer performance specifications. A support team of technical, research, administrative and academic staff based at CEMAS provides comprehensive support to all users through a variety of mechanisms from contract research to collaborative projects.

#### CEMAS KEY FEATURES

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- A unique, custom-designed environment where every instrument meets or exceeds manufacturer performance specifications
- Highly skilled support staff available to all users
- The electron microscopy collaboratory: a digital theater providing remote access to allow students and lecturers to seamlessly operate electron and ion microscopes
- Delivering solutions to medicine, advanced manufacturing, environmental science, energy harvesting and storage, and healthcare
- Comprehensive computer facilities for processing, simulation, and visualization of 2D and 3D datasets
- Extensive sample preparation laboratories for engineering, physical and biological sciences



Center for Electron  
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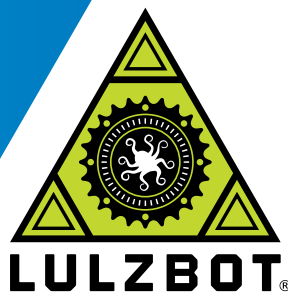


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2019 COLUMBUS

# TECHNICAL PROGRAM



[biofabrication2019.org](http://biofabrication2019.org)

# PROGRAM-AT-A-GLANCE

Please note that all times are in Eastern Daylight Savings Time (EDT) -0500 UTC.

Morning						
Sunday October 20	Registration	International Society for Biofabrication (ISBF) - Board of Directors Meeting (private) BWH 8:30 - 11:30 am				Biofabrication 2019 Convocation
	LOB	The Ohio State University Lab Tours Meeting Point at LOB 9:00 am - 11:00 pm				AGB
	9:00 - 6:30 pm	Workshop: 3D Bioprinting of Tissue Models for Drug Discovery PHA 9:30 am - 11:30 pm				12:00 - 1:00 pm
Monday October 21	Registration	Plenary Session 2 by Jennifer Lewis	Sessions 4 - 6	Coffee & Exhibits	Sessions 4 - 6	YSF 1 <sup>++</sup> Meet the Editor
	LOB	AGB	AGB PHA USB	WBR	AGB PHA USB	PHA 11:30 am - 1:00 pm
	7:30 - 5:30 pm	8:00 - 9:00 am	9:00 - 10:00 am	10:00 - 10:30 am	10:30 - 11:30 am	
Tuesday October 22	Registration	Plenary Session 4 by Wei Sun	Sessions 10 - 12	Coffee & Exhibits	Sessions 10 - 12	YSF 3 <sup>++</sup> Meet the Legends
	LOB	AGB	AGB PHA USB	WBR	AGB PHA USB	PHA 11:30 am - 1:00 pm
	7:30 - 5:30 pm	8:00 - 9:00 am	9:00 - 10:00 am	10:00 - 10:30 am	10:30 - 11:30 am	
Biofabrication Technology Exhibition						

Conference Locations:

- AGB: Archie Griffin Ballroom - East (\*\*\*, 2<sup>nd</sup> Floor)
- BWH: The Blackwell Hotel
- OSU Campus, 2110 Tuttle Park Pl, Columbus, OH 43210
- CAM: Columbus Art Museum
- Downtown, 480 E Broad St, Columbus, OH 43215
- CHU: Chumley's
- 1516 N High St, Columbus, OH 43201
- LOB: Lobby // Great Hall Table - Art Gallery (\*\*\*, 1<sup>st</sup> Floor)
- PHA: Performance Hall (\*\*\*, 1<sup>st</sup> Floor)
- TRA: Traditions Room (\*\*\*, 2<sup>nd</sup> Floor)
- USB: US Bank Conference Theater (\*\*\*, 1<sup>st</sup> Floor)
- WBR: Archie Griffin Ballroom - West (\*\*\*, 2<sup>nd</sup> Floor)

\*\*\* OSU Campus, Ohio Union: 1739 N High St, Columbus, OH 43210



# PROGRAM-AT-A-GLANCE

Please note that all times are in Eastern Daylight Savings Time (EDT) -0500 UTC.

Afternoon					Evening
<b>Plenary Session 1</b> by Jos Malda  AGB  1:00 - 2:00 pm	<b>Sessions 1 - 3</b>  AGB PHA USB  2:00 - 4:00 pm	<b>Snack &amp; Exhibits</b>  WBR  4:00 - 4:30 pm	<b>Poster Session 1</b>  PHA  4:30 - 6:30 pm		<b>Conference Reception</b>  BWH  7:00 - 9:30 pm
	Technology Exhibition				
<b>Plenary Session 3</b> by Anthony Atala  AGB  1:00 - 2:00 pm	<b>Sessions 7 - 9</b>  AGB PHA USB  2:00 - 4:00 pm	<b>Snack &amp; Exhibits</b>  WBR  4:00 - 4:30 pm	<b>Poster Session 2</b>  PHA  4:30 - 5:30 pm	<b>ISBF Annual Business Meeting</b>  AGB 5:30 - 6:30 pm	<b>YSF 2<sup>++</sup> Reception</b> CHU 7:30 - 10:00 pm
	Biofabrication Technology Exhibition				<b>Workshop: Federal Funding Landscape for Biofabrication and the Power of ARMI</b> PHA 6:30 - 8:30 pm
<b>Plenary Session 5</b> by Ali Khademhosseini  AGB  1:00 - 2:00 pm	<b>Sessions 13 - 15</b>  AGB PHA USB  2:00 - 4:00 pm	<b>Snack &amp; Exhibits</b>  WBR  4:00 - 4:30 pm	<b>Awards &amp; Closing Ceremony</b>  AGB  4:30 - 5:30 pm	<b>University of Wollongong Reception</b>  WBR  5:30 - 6:30 pm	<b>Champagne Reception</b> CAM 7:00 - 8:00 pm
	Technology Exhibition				<b>Gala Dinner</b> CAM 8:00 - 11:00 pm

Conference Activities:

++ YSF: Young Scientist Forum

# Designing, Developing, and Manufacturing with Native Polymers

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# TECHNICAL PROGRAM

Please note that all times are in Eastern Daylight Savings Time (EDT) -0500 UTC.

Abstracts are available in the meeting app and may be downloaded from [www.biofabrication2019.org](http://www.biofabrication2019.org).

## PARALLEL SESSIONS - Sunday October 20th, 2019

	Session 01 - Bioinks 1	Session 02 - Liver	Session 03 - Design, Simulation & Monitoring
2:00 to 2:30 pm	"KEYNOTE - Synthetic building blocks for injectable regenerative materials" by Laura De Laporte, Leibniz Institute for Interactive Materials, GERMANY	"KEYNOTE - 3D Bioprinting of In Vitro Metastatic Cancer Models" by Angela Panoskaltsis-Mortari, University of Minnesota, USA	"KEYNOTE - A Multifunctional DNA-origami platform for Biomolecular Detection in Cellular Microenvironments" by Carlos Castro, The Ohio State University, USA
2:30 to 2:45 pm	"Development of Nanostructured Alginate-Gelatin -Based Inks for 3D Bioprinting of Bone Cells" by Jannika Paulamäki	"3D Bioprinting of multiphasic and multicellular osteochondral tissue substitutes featuring a spatially defined distribution of cell types and differentiation factors" by David Kilian	"Physics of Cellular Self-Assembly– A Microscopic and Mathematical Model for Faster Maturation of Bioprinted Tissues " by Ashkan Shafiee
2:45 to 3:00 pm	"Tunable Multifunctional Bioinks for 3D Printing Applications in Bone Regeneration" by Songyang Li	"Hyaluronic Acid- ECM Biomimic Peptide Hydrogel for Study of Liver Fibrosis" by Andrea Mazzocchi	"Mechanical modelling provides versatile design tools for composite scaffold biofabrication" by Mark Allenby
3:00 to 3:15 pm	"Modification of PDMS Rheology and Machine Pathing to Improve Freeform Reversible Embedding" by Maria Stang	"Fabrication of a microfluidic-nanofibers based cell culture platform for hepatocellular carcinoma" by Jeong Hwa Kim	"Development of a Suspension Near-Field Electrospinning Technique for the Fabrication of Three-Dimensional Nanostructures" by Alex Nagle
3:15 to 3:30 pm	"Hybrid Bioink 3D Printing for Soft Tissue Grafts" by Sarah Van Bellegem	"3D Cell Printing of Prevascularized Stem Cell Patch for Treatment of Liver Cirrhosis" by Wonil Han	"Label-Free Detection of Cell Viability for Drug-Response Relationship in 3D Cellular Constructs via Dielectric Spectroscopy" by Binil Starly
3:30 to 3:45 pm	"Development of Catechol Based Adhesive Bioink for 3D Printing" by Ying Zhou	"3D bioprinting of hepatocytes– core/shell structured cocultures with fibroblast for enhanced functionality" by Rania Abdelgaber	"Investigation of Dielectric Impedance Spectroscopy for Layer-wise Non-destructive Monitoring of Cell Viability in 3D Bioprinting" by Rohan Shirwaiker
3:45 to 4:00 pm	"Development of a Universal Bioink Technology for Multi-Modality Bioprinting Compatibility and Support of Multiple Tissue Construct Types" by Aleksander Skardal	"Bio-dot printing for precise positioning and in-situ formation of cell spheroids" by Seunggyu Jeon	"Real time imaging of local oxygen concentrations enables evaluation of oxygen diffusion in hydrogel bioinks and cell metabolism in 3D bioprinted constructs" by Ashwini Rahul Akkineni

# TECHNICAL PROGRAM

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Abstracts are available in the meeting app and may be downloaded from [www.biofabrication2019.org](http://www.biofabrication2019.org).

## PARALLEL SESSIONS - Monday October 21st, 2019

	Session 04 - Musculoskeletal 1	Session 05 - Bioinks 2 & Kidney	Session 06 - Gastro 1
9:00 to 9:30 am	"KEYNOTE - 3D Printing with Living Cells" by Gordon Wallace, University of Wollongong, AUSTRALIA	"KEYNOTE - Expanding the Biomaterial Toolbox for Biofabrication: From Development to Commercialization" by Ramille Shah, University of Illinois at Chicago, USA	"KEYNOTE - Mapping the ovarian matrisome to better inform an engineered bioprosthetic ovary" by Monica M. Laronda, Northwestern University, USA
9:30 to 9:45 am	"Integration of Full-thickness Bioprinted Skin Accelerates Epidermal Stratification and Normal Tissue Formation" by Adam Jorgensen	"Mesoporous Bioactive Glass with Improved Osteogenic and/or Antibacterial Properties for 3D Printing and Bioprinting" by Vera Guduric	"Validation of Synthetic and Decellularized Matrix Hybrid Spiral for Long Segment Tracheal Reconstruction " by Stacey Gruber
9:45 to 10:00 am	"Entangled Inks – an easy and fast approach to 3D bioprint macroporous hydrogel scaffolds" by Benjamin Kessel	"A Gelatin-based Interpenetrating Polymer Network Hydrogel as a Promising Ink for Bioprinting Applications" by Veerle Bloemen	"Bioprinted Trachea Constructs with Patient Matched Design, Mechanical and Biological Properties" by Sean Murphy
10:30 to 10:45 am	"Supplementation of an alginate/methylcellulose bioink with human plasma strongly stimulates human mesenchymal stem cells in a bioprinted bone-like, mineralized tissue construct" by Michael Gelinsky	"Potentials assessment of spinal cord tissue derived bioink in printing induced pluripotent stem-cell derived motor neuron printing for the fabrication of neuromuscular system" by Jeong Sik Kong	"Laser-assisted bioprinting based approach for the study of cell plasticity in the scope of pancreatic cancer" by Hugo Oliveira
10:45 to 11:00 am	"Endothelial cells support osteogenesis in a vascularized 3D bioprinted in vitro bone model" by Irene Chiesa	"Engineering a Living Kidney Proximal Tubule via Melt Electrowriting" by Anne Metje van Genderen	"A coaxial bioprinting platform for biofabrication of implantable islet-containing constructs" by Zhilian Yue
11:00 to 11:15 am	"Bioprinting 2-Dimensional and 3-Dimensional Exosome Microenvironments" by Saigopalakrishna Yerneni	"3D Bioprinted Renal Tissue Constructs using a Novel Photocrosslinkable kidney ECM-derived Bioink" by Sang Jin Lee	"Engineering Vascularized Islet-mimetic Organoid from Human Pluripotent Stem Cells" by Connor Wiegand
11:15 to 11:30 am	"Finding the Balance between Cell Functionality and Shape Fidelity of 3D Bioprinted Constructs" by Khoon Lim	"Formulating for 3D printing: high throughput screening of inks for inkjet 3D printing multi- functional drug delivery implants" by Laura Ruiz-Cantu	"High-precision Inkjet Technology with Biocompatible Hydrogel" by Momoko Shionoiri

# TECHNICAL PROGRAM

Please note that all times are in Eastern Daylight Savings Time (EDT) -0500 UTC.

Abstracts are available in the meeting app and may be downloaded from [www.biofabrication2019.org](http://www.biofabrication2019.org).

## PARALLEL SESSIONS - Monday October 21st, 2019

	Session 07 - Musculoskeletal 2	Session 08 - Brain & Neuro	Session 09 - Gastro 2
2:00 to 2:30 pm	"KEYNOTE - Advanced Biofabrication Methods for Large Cartilage Organs" by Marcy Zenobi-Wong, ETH Zurich, SWITZERLAND	"KEYNOTE - Emulsion Inks for 3D Printing of Tissue Engineering Scaffolds" by Elizabeth Cosgriff-Hernandez, University of Texas at Austin, USA	"KEYNOTE - Differentiation of pluripotent stem cells towards nephron progenitor cells for bioprinted renal in vitro model" by Carlos Mota, Maastricht University, THE NETHERLANDS
2:30 to 2:45 pm	"In vivo evaluation of 3D bioprinted osteochondral implants with hierarchical fiber orientation and cellular distribution" by Mylene de Ruijter	"The Construction of GBM Invasion Model Based on 3D Bioprinting" by Liang Ma	"Personalized Tumor Model: From Patient Tumor to Three-dimensional Printing of in vitro Model and Drug Testing" by Mao Shuangshuang
2:45 to 3:00 pm	"Tissue adhesive bioink as cell carrier and cartilage-binding glue for bioprinting and chondral regeneration" by Riccardo Levato	"Development of Vascularized Outer Blood-Retinal-Barrier Model using 3D Cell Printing Technology" by Jongmin Kim	"Human Villi-on-a-Chip with Capillary on 3D-Printed Scaffolds" by Chen-Yu Chen
3:00 to 3:15 pm	"Actin microfilaments and microtubule networks contribute differently to biomechanical properties of tissue spheroids" by Elena Bulanova	"On-Chip 3D Printing of a Blood-Brain Barrier Model" by Agnes Dobos	"3D in vitro model of human gut microbiota" by Francesco Biagini
3:15 to 3:30 pm	"The Effect of BMP-Mimetic Peptide-Tethering Bioinks on the Differentiation of Human Dental Pulp Stem Cells in the Bioprinted Dental Construct" by Sang Jin Lee	"Neural Cell Integration into 3D Bioprinted Skeletal Muscle Constructs for Restoration of Muscle Function" by Ji Hyun Kim	"Evaluation of Laminin and Fibronectin Impact on Metastasis in a Tumor-on-a-Chip Microfluidic Platform" by Kylie Nairon
3:30 to 3:45 pm	"Hybrid Melt Electrospun Writing PCL and Hydrogel Scaffolds for Wound Healing Applications" by Bahattin Koc	"Development Of An In Vitro Functional 3D Blood Brain Barrier Model For Use In A Brain Microfluidic Model" by Thomas DePalma	"Novel strategy for the biofabrication of a thick, functional, 3D vascularized hepatic tissue model" by Sarah Bushman
3:45 to 4:00 pm	"Ligament reconstruction using Scaffold-free Cell Construct produced by Bio Three-dimensional Printer." by Daiki Murata	"3D-bioprinted lattices for efficient expansion of neural stem cells" by Chris Lindsay	"Alginate-based bioinks for bioprinting of pancreatic islets and blood vessels with a coaxial needle setup" by Joanna Idaszek

# TECHNICAL PROGRAM

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## PARALLEL SESSIONS - Tuesday October 22th, 2019

	Session 10 - Novel Processing 1	Session 11 - Cardio & Vascular 1	Session 12 - Musculoskeletal 3
9:00 to 9:30 am	"KEYNOTE - Bioprinting Scaffolds for Tissue Engineering Applications " by Daniel Chen, University of Saskatchewan, CANADA	"KEYNOTE - Stromal cells promote neovascular invasion across tissue interfaces" by Hannah Strobel, Advanced Solutions Life Sciences, USA	"KEYNOTE - Combination of smart and biodegradable materials and biofabrication techniques for the treatment of osteoporotic fractures: the challenge of GIOTTO project" by Giovanni Vozzi, Università di Pisa, ITALY
9:30 to 9:45 am	"Facile Biofabrication of Complex Multilayered Tubular Constructs" by Liliang Ouyang	"Fabrication of all-nanofiber, hybrid-type nanofiber mat for the development of the multi-layered cardiac patch" by Seongsu Eom	"A 3D model of the human omentum designed by bioprinting technology" by Manuela Estermann
9:45 to 10:00 am	"Using chaotic printing to fabricate microstructure at high resolution and speed" by Grissel Trujillo-de Santiago	"Over-Five-Millimeter Diameter Alginate-Collagen Endothelialized Tubular Scaffold Formation for Large Diameter Blood Vessel Fabrication" by Thuy Duong	"Hybrid Printing Using Cellulose Nanocrystals Reinforced Hydrogels for Cartilage Tissue Engineering" by Yuchao Fan
10:30 to 10:45 am	"Fabrication of calcium phosphate 3d scaffolds for bone repair using magnetic levitational assembly" by Vladislav Parfenov	"Coaxial Cell Printing of Freestanding, Perfusable and Functional in vitro Vascular Models for Recapitulation of Native Vascular Endothelium Pathophysiology" by Ge Gao	"Bioengineering of Skeletal Muscle Tissue with Innervation Capability for Accelerated Restoration of Pelvic Floor Muscle Function" by Ji Hyun Kim
10:45 to 11:00 am	"Mediated Electrochemical Biofabrication Mimicking Oxidative Matrix Assembly" by Jinyang Li	"FRESH 3D Printing a Contractile Model of the Human Left Ventricle" by Andrew Lee	"Spatio-Temporal Modulation of Oxygen Gradients in Biofabricated Gelatin-Heparin Constructs for Zone Specific Tissue Alignment and Homogenous Hyaline Cartilage Regeneration" by Gabriella Lindberg
11:00 to 11:15 am	"Hybrid laser platform for printing 3D multiscale multi-material hydrogel structures" by Pranav Soman	"Sustained Perfusion for Improved Long-Term Viability in Large Bioprinted Constructs" by Kelsey Willson	"Eluting moulds for patient specific graft fabrication" by Enrico Tosoratti
11:15 to 11:30 am	"4D Maturation control of tissues produced by Laser-Assisted Bioprinting (LAB)" by Camille Douillet	"High Resolution Vascular Structures Produced by Inkjet Printing" by Fei Zheng	"Engineered bi-layered microfibre reinforced hydrogel for zonal cartilage repair" by Miguel Castilho



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## PARALLEL SESSIONS - Tuesday October 22th, 2019

	Session 13 - Novel Processing 2 & On-Chip applications	Session 14 - Cardio & Vascular 2	Session 15 - Cancer & Regulatory
2:00 to 2:30 pm	"KEYNOTE - Convergence of Biofabrication and Microphysiological Organ-on-a-Chip Technologies for High Throughput Screening" by Tim Woodfield, University of Otago, NEW ZEALAND	"KEYNOTE - Biofabrication of tubular grafts via melt electrowriting and combined approaches" by Tomasz Jüngst, University of Würzburg, GERMANY	"KEYNOTE - The Use of Thermal Inkjet Printed Cell Activation for Tissue Engineering and Cancer Models" by Thomas Boland, University of Texas at El Paso, USA
2:30 to 2:45 pm	"Anisotropic Scaffold Fabrication using High-Throughput 3D-Melt Blowing" by Rohan Shirwaiker	"Bioprinting of Complex 3D Vascular Networks within Cell-Laden Hydrogels" by Murat Guvendiren	"An integrated cell printing approach for the construction of heterogeneous tumor models" by Tiankun Liu
2:45 to 3:00 pm	"Electrolyte solution-assisted electrospray deposition : Improved electrospraying process for direct coating of nanoparticles with high deposition efficiency" by Seong Jin Lee	"Drug response of scaffold-free cardiac constructs fabricated using bio-3D printing" by Kenichi Arai	"Miniature 3D bioprinting of neural stem cells on pillar plates for developmental neurotoxicity assays" by Moo-Yeal Lee
3:00 to 3:15 pm	"Micro-3D-printing of biological cell niches" by Amelie Erben	"Induction of designed micro-vascular network with 3D bioprinting" by Jeonghyun Son	"Accessible Ossicle Model for Studying Tumor-Induced Bone Disease" by David Florian
3:15 to 3:30 pm	"Advanced Firmware and Hardware for Multiscale and Multimaterial Bioprinting" by Carmelo De Maria	"The Role of IL-10 in Host Response to Tissue Engineered Vascular Grafts" by Gabriel Mirhaidari	"Model of Patient-Specific Immune Enhanced Tumor Organoids for Immunotherapy Screening" by Aleksander Skardal
3:30 to 3:45 pm	"Directed Collective Cell Migration Using Three-Dimensional Bioprinted Micropatterns on Thermoresponsive Surfaces for Myotube Formation" by Dhvanit Shah	"Magnetic levitational biofabrication in Space" by Vladislav Parfenov	"KEYNOTE - Drawing Creatively within the Lines: Regulatory Approaches for Emerging Regenerative Medicine Therapies" by Richard McFarland, ARMI/BioFabUSA, USA
3:45 to 4:00 pm	"Femtosecond laser induced densification within cell-laden hydrogels results in cellular alignment" by Pranav Soman	"Between Air and Liquid: A Physiologically Relevant Pulmonary Organoid" by Timothy Leach	

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## Sunday October 20th, 2019

### 4:30 to 6:30 pm Poster Session 1

"3D bioprinting for future space exploration – the European perspective" by Michael Gelinsky

"3D BioPrinting in Suspension Media as a Disruptive Technology in Tissue Engineering" by Ferry Melchels

"3D Bioprinting of a Mechanically Reinforced Hybrid Tissue Construct for Advanced Fibrocartilaginous Regeneration" by Sang Jin Lee

"3D bioprinting of hybrid and gradient structures for critical size bone defects" by Bahattin Koc

"3D Bioprinting of multiphasic and multicellular osteochondral tissue substitutes featuring a spatially defined distribution of cell types and differentiation factors" by David Kilian

"3D Bioprinting with Light Active Tissue-specific Bioink to Improve Structural Fidelity and Tissue Function" by Se-Hwan Lee

"3D Cell Printing of Perfusable and Vascularized Human Skin Equivalents Composed of Epidermis, Dermis, and Hypodermis for Better Recapitulation of Skin Anatomy" by Byoung Soo Kim

"3D Hydrogels and Bioinks for Realistic In-Vitro Modelling and Bioprinting" by Elia Lopez-Bernardo

"3D printing of chitosan-based scaffolds for wound healing" by Sulokshana Marks

"3D-patient derived ovarian tumour model to investigate early stages of high-grade serous ovarian cancer" by Francesca Paradiso

"A Bioprinted Multicellular Glioblastoma Model" by Nathalie Dusserre

"A Comprehensive Study towards a Scalable and Reproducible Synthesis of Bioinks and its Sterilisation " by Sanjeev Gambhir

"A High-throughput Approach for the Investigation of 3D-printed Hydrogel Materials for Biocatalytic Reactors" by Lukas Wenger

"A Multifunctional DNA-origami platform for Biomolecular Detection in Cellular Microenvironments" by Melika Shahhosseini

"A Novel Controllable Cell Array Printing Technique on Microfluidic Chips" by Sheng Li Mi

"A Surgical Robotics Based Additive Manufacturing Tool for Intracorporeal Tissue Engineering" by Andrej Simeunovic

"A Versatile, Enabling Platform for Vascularizing Tissues and Tissue Models" by James Hoying

"Aligned Electroconductive Electrospun Patch as a Novel Biomaterial for Cardiac Tissue Engineering" by Chiara Mancino

"Altered myeloid-derived cell populations by bisphosphonates results in changes to the development of tissue engineered vascular grafts." by Gabriel Mirhaidari

"Application of Additive Manufacturing for Novel Transcatheter Heart Valve Stents" by Megan Heitkemper

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**Sunday October 20th, 2019**

## 4:30 to 6:30 pm Poster Session 1

- |  |   |
|--|---|
| "Aspiration-assisted Bioprinting" by B. Ayan   | "Collaborative robotic arm-based bioprinter for in-situ bioprinting" by Carmelo De Maria  |
| "Assessing the Bioprintability of Self-Assembling Peptide Bioinks: Structure Fidelity and Cell Viability" by Zainab Khan   | "Collagen-based materials from bench to the bedside: a long journey" by Francesca Taraballi   |
| "Automated Biomanufacturing Platform for Perfused Tissues" by James B Hoying   | "Comparing the properties of various sources of collagen hydrogels for bioprinting and tissue engineering" by Malachy Maher           |
| "Bioengineered perist membrane combining $\mu$ -spheroids and melt electro-writing technology" by Angela Pastore   | "Computational Simulation of Cell Spheroids Fusion for Tissue Engineering Applications" by Nicanor Moldovan                           |
| "Biofabrication of the tubular construct of tissue spheroids in an ultrasonic field" by Elena Bulanova   | "Cranial bone regeneration using printer-designed scaffold with human dental pulp stem cells" by Moon Suk Kim                         |
| "Biomimetic Design Strategy of 3D Bioprinted Bone Construct for Craniomaxillofacial Reconstruction" by Hyeongjin Lee   | "Design and Electrospinning of Patient-Specific Tissue-Engineered Bifurcated Right Ventricle-Pulmonary Artery Grafts" by Kevin Nelson |
| "Biomolecules of Recombinant rhBMP-7 and rhVEGF<SUB>165</SUB> Protein Self-assembled on Electrospun PCL Fiber by LbL Technique for Tissue Regeneration" by Luiz Catalani | "Design and optimization of an orthopedic lattice-based hemiprosthesis for the proximal humerus." by Erick Ramirez-Cedillo            |
| "BioPapers: naturally-derived biopolymers for next generation cell culture" by James Dolgin  | "Design of Various Polymeric Fiber Architectures for Tissue Engineering via 3D Electro Jetting" by Anke Steier                        |
| "Characterization of a Poly(lactic-co-glycolic) Acid - Hydroxyapatite 3D-printed scaffolds for bone tissue engineering" by Joanna Babilotte                              | "Design Optimization of Braided Arterial Vascular Graft to Promote Neovessel Remodeling" by Jacob Zbinden                             |
| "Characterization of Commercial Photoinitiators and UV-Absorbers in DLP Bioprinting" by Jun Tae Huh  | "Development of a decellularized extracellular matrix based bio-ink having an enhanced 3D printability" by Wonwoo Jeong               |

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## Sunday October 20th, 2019

### 4:30 to 6:30 pm Poster Session 1

"Development of a Device to Fabricate Sutures Coated with Functionalized Electrospun Nanofibers" by Katherine Magee

"Development of a Mist-based Printhead for 3D Bioprinting of Alginate Scaffolds" by Ben MacCallum

"Development of a high-throughput approach to imaging and sorting of 3D cell culture" by Daiki Murata

"Development of an Artifact for Assessing Bioink Printability" by Gregory Gillispie

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## Monday October 21th, 2019

### 4:30 to 5:30 pm Poster Session 2

"Development of collagen coated, aligned nanofiber membrane for enhanced vascular endothelial barrier function" by Dohui Kim

"Direct-Write Additive Manufacturing and Characterization of Visible Light Crosslinkable GelMA\Laponite\Methylcellulose Hydrogel at Physiological Temperature" by Ali Asghari Adib

"Dual Crosslinking of Methacrylated Hyaluronic Acid" by Tom Bobula

"Effect of Dexamethasone on the 3D Print Quality and Degradation of a Soft Amorphous Polyester " by Abraham Joy

"Effect of fluid-flow induced shear stress on fibroblast-like synoviocytes in a bioinspired synovium on-chip" by Susanna Piluso

"Effects of the protein folding state on the mechanical properties of hydrogels produced by photoinduced crosslinking of unmodified proteins (PICUP)" by Sandra Haas

"Electrospinning Methods for the Production of Resorbable Bifurcated Vascular Grafts: Influence of process parameters on mandrel adherence and mechanical properties" by Raquel Tejeda-Alejandre

"Equalized Flow through Microchannels of Bioreactor SSuPer Modules" by T.J. Segó

"Fabrication and characterization of three-layered composite nerve repair conduit via electrohydrodynamic jetting, dip-coating, and electrospinning" by Suihong Liu

"Fabrication of a graded micropillar-arrayed surface for guided cell migration" by Changxue Xu

"Fabrication of collagen fibril surface using core (PCL)-shell (gelatin/PVA/ceramic) scaffold" by Haeri Kim

"Fabrication of Scaffolds with Engineered Multiscale Prevascular Networks" by Shuai Li

"Freeform Reversible Embedding 3D Printing of Carbon Fiber Reinforced Epoxy Composites" by Neeha Dev Arun

"FRESH 3D Bioprinting of Trachea Scaffolds Using Decellularized Extracellular Matrix" by Joshua Tashman

"Gelatin based Bioink Formulations for 3D Bioprinting" by Gangadhar Panambur

"How to Determine a Suitable Sodium Alginate for the Fabrication of Standardized Alginatedialdehyde-Gelatin crosslinked Hydrogels in Biofabrication Approaches?" by E. Karakaya

"Hybrid Decellularized Matrix-Polylactic Acid Microsphere Embedded Injectable/ 3D Printable System for Osteochondral Regeneration" by Sumit Murab

"Impact of pore architectures in 3D printed bioceramic scaffolds on orthotopic bone regeneration in an equine model" by Riccardo Levato

"Improving Cellular Replacement Therapy for Parkinson's Disease Using 3D Nanofibrous Ultrashort Self-Assembling Peptide Based Scaffolds" by Sherin Abdelrahman

"In vivo outcome of bioprinted cartilage tissue using an advanced enzymatically crosslinkable bioink" by Philipp Fisch

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## Monday October 21th, 2019

### 4:30 to 5:30 pm Poster Session 2

"Investigation of Dielectric Spectroscopy as an Enabling Tool for Process Analytical Technology in 3D Biofabrication" by Trevor Thompson

"Is there an optimum in the design of alginate-based composite bioinks for 3D bioprinting regarding the filler concentration?" by Susanne Heid

"Low-Cost 3D Printing of Corneal Stroma Scaffolds " by Xu Zhang

"Micro-Machining of Natural Polymers for Use as Scaffolds and Tissue-on-a-Chip Applications" by Justin Baker

"Microstructural Characteristics of the Peripheral Nerve Endoneurium for Biomimetic Scaffold Design" by Liwei Yan

"Microvessel structures based on thermoresponsive polyoxazolines for biofabricated tissue models: Efficacy of network endothelialization" by Hatice Genc

"Modeling and Experimental Characterization of Biocompatible Bone Scaffolds, Fabricated Using Fused Deposition Modeling Additive Manufacturing Process" by Roozbeh (Ross) Salary

"Non-genetic Cell Membrane Modification of Mesenchymal Stromal Cells (MSCs) with Chemically Self-Assembling Nanorings (CSANs)" by Justine Delgado

"Personalized Completely Biodegradable Stent Fabricated by 3D Printing" by Lei Zhang

"Physiological Three-Dimensional Bioprinting and Culturing of Mouse Myoblasts within Ultrashort Peptide Scaffolds" by Dana Alhattab

"Preparation of nanofibrous collagen coated PCL surface to enhance myotube formation" by Jiun Lee

"Printing Complex Sustainable Constructs using Self-Assembling Ultrashort Peptides" by Kowther Kahin

"Rapid 3D printing of functional nanoparticle-enhanced conduits for effective nerve repair" by Jie Tao

"Reciprocal Control of Hierarchical DNA Origami-Nanoparticle Assemblies" by Joshua Johnson

"Recombinant Human Type I Collagen - a Flexible BioInk Platform for 3D-Bioprinting" by Nadav Orr

"Revealing critical parameters for predicting the bioprintability of hydrogel systems" by Stefan Schruefer

"Rotator cuff regeneration with a graded biomimetic patch using 3D cell printing technology" by Jae Yeon Lee

"Soft tissue bionics biofabrication and engineering anatomy" by Canbin Zheng

"Structuring Bioinks with Subcellular Resolution" by Aleksandr Ovsianikov

"Synthesis and Characterization of Naturally Derived Bioinks for 3D Bioprinting" by Cancan Xu



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## Monday October 21th, 2019

### 4:30 to 5:30 pm Poster Session 2

"Synthesis and Photocrosslinking of Unsaturated Polymers Derived From Isosorbide for 3D Printing Applications" by Isabela Dourado

"The effect of aligned extracellular matrix nanofibers combined with 3D printed micropatterned poly(lactide-co-glycolide) scaffold on skeletal muscle cell orientation and maturation" by WonJin Kim

"Thermally Insensitive Gelatin-based Bioinks for Visible Light Stereolithography 3D Bioprinting" by Hitendra Kumar

"Thermomechanical Processing Techniques for Magnesium Calcium Zinc Alloys" by Thomas Avey

"Three Dimensional Monolayer Culture of Epithelial Cells on Poly(vinyl alcohol) Nanofibrous Membrane Containing Integrin-binding Ligands" by Jong-Young Kwak

"Ultrasound-assisted Bioprinting of Preferentially Aligned 3D Cellular Constructs" by Rohan Shirwaiker

"Universal Nano-carrier Ink for Biomaterials Additive Manufacturing" by Elia Guzzi

"Utilization of Micro-Tumor Constructs for Testing of Chemotherapy Regimens" by Steven Forsythe

# NOTES

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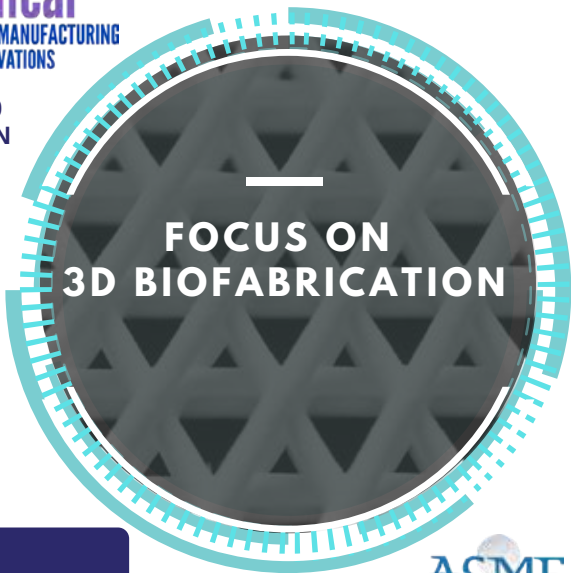
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Minneapolis, MN

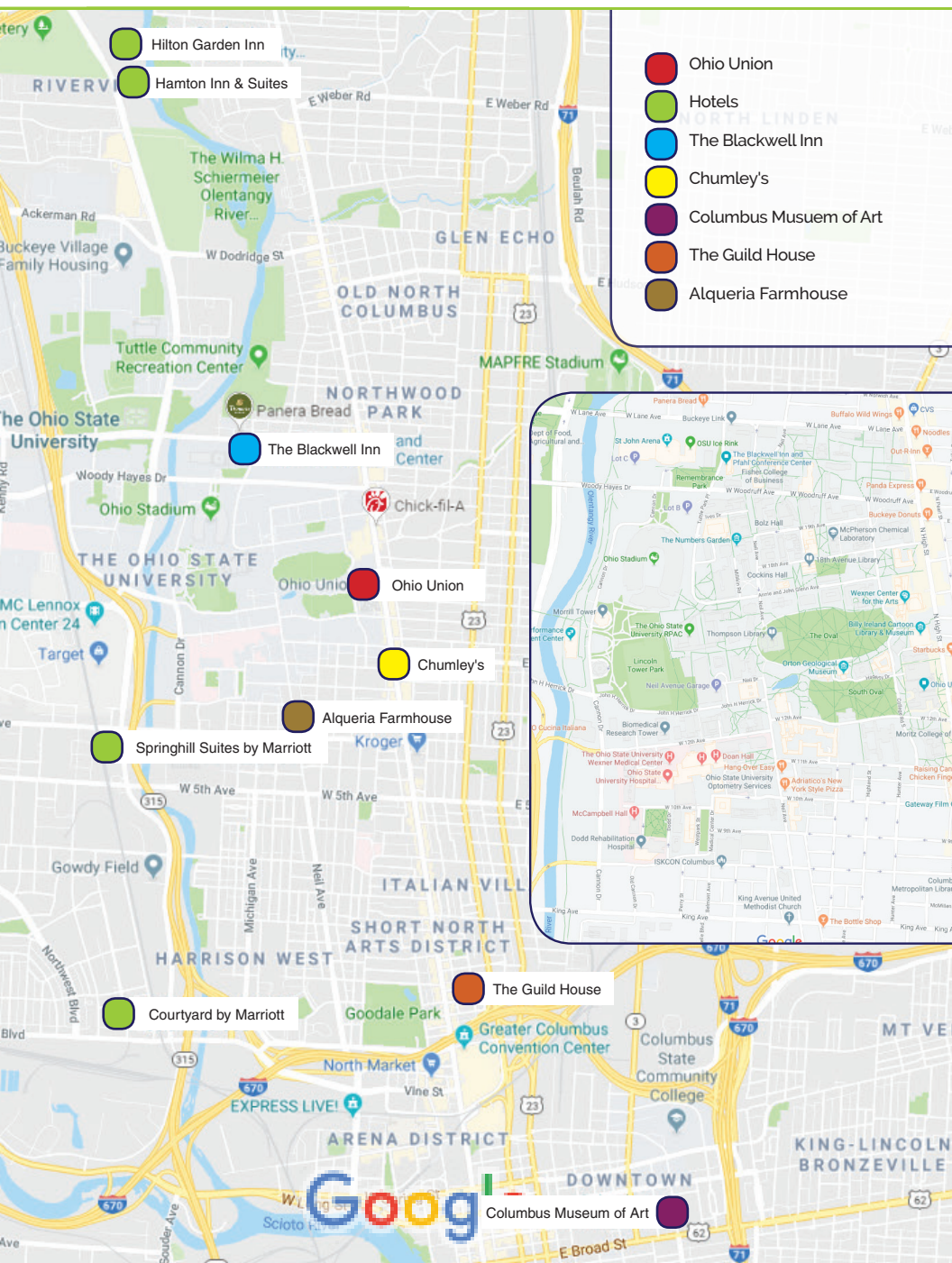


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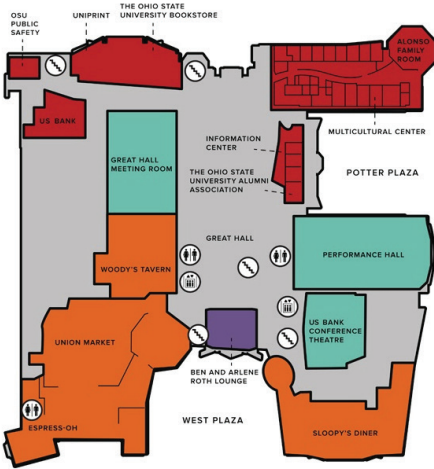
# LOCAL AREA MAP

Map courtesy of Google Maps



# OHIO UNION FLOORPLAN

## FIRST FLOOR



## SECOND FLOOR



## THIRD FLOOR

