LEVERAGING CONVERGENCE TO DEMOCRATIZE BIOMANUFACTURING

Kimani C. Toussaint, Jr.

https://sites.brown.edu/probelab/

Laboratory for the Photonics Research Of
Bio/nano Environments (PROBE)

School of Engineering

Brown University

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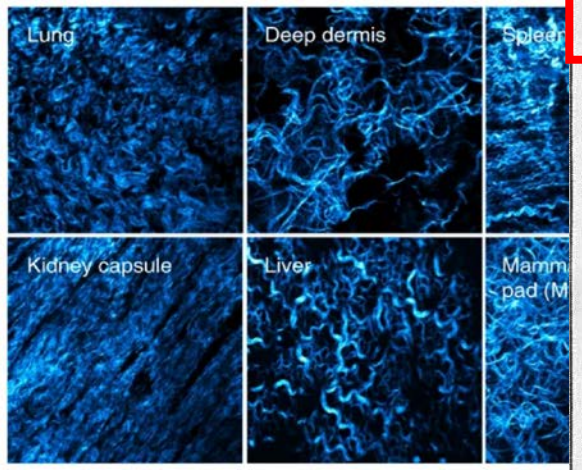
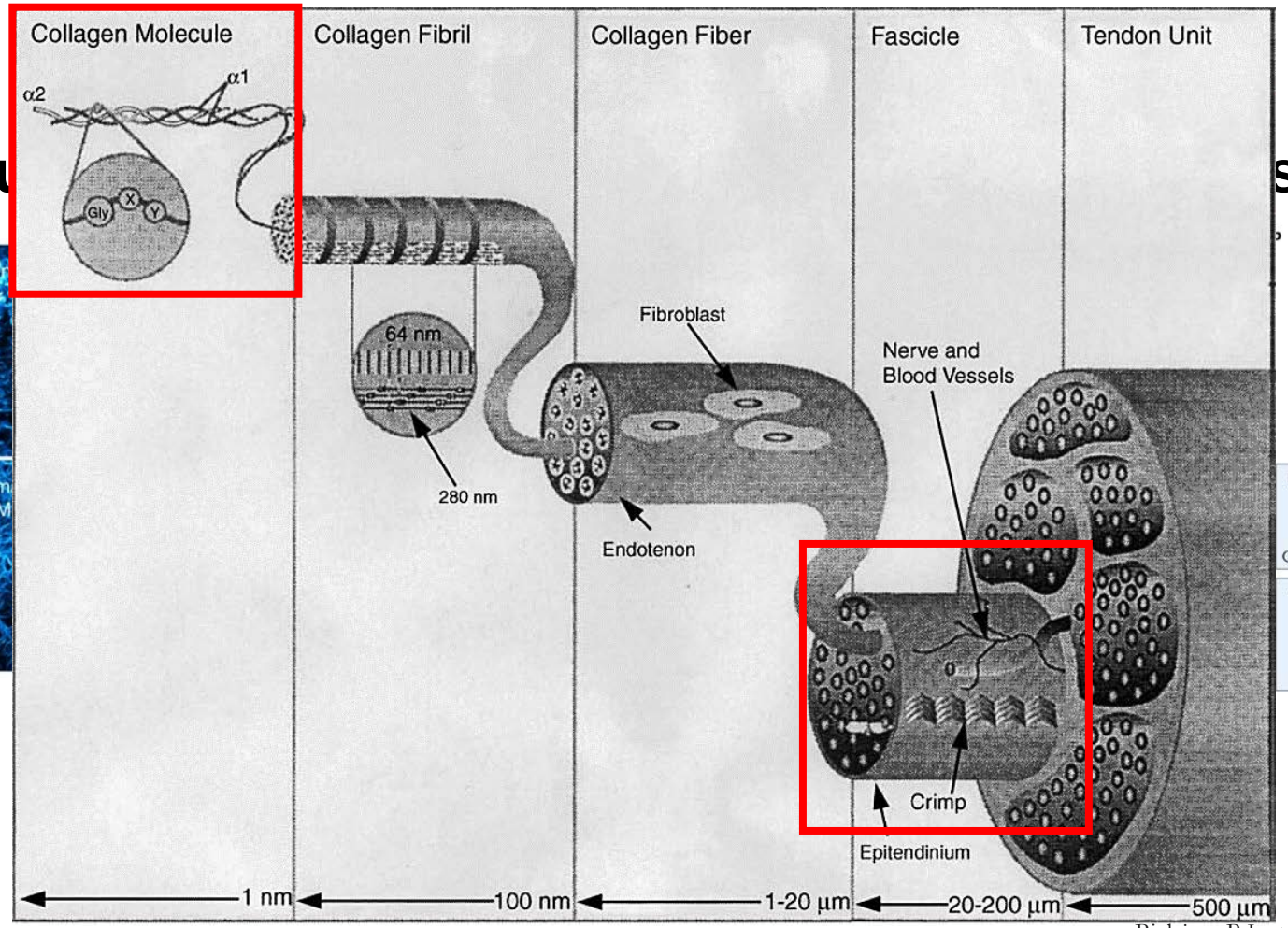
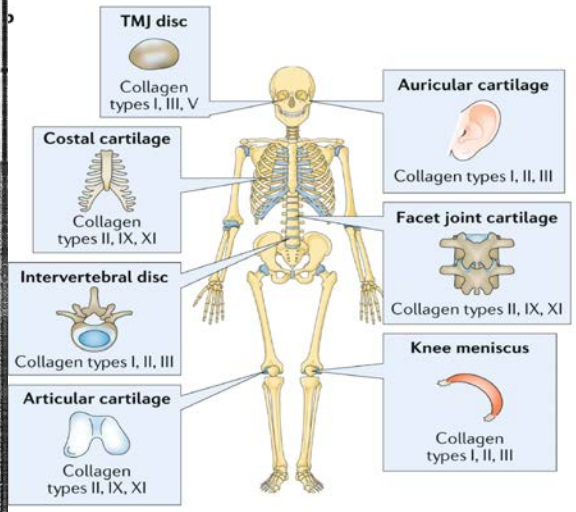
MULTISCALE HETEROGENOUS BIOMATERIALS

Heterogeneity exists in biology in the form of composition and structure spanning multiple hierarchical (spatial) scales to introduce a variety of functionalities

Stru **sition**







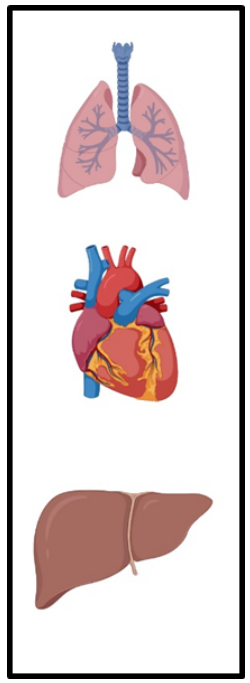
Park, D. et al. / Nature Materials 19 (2020) 227-238
Bielajew, B.J. et al. / Nature Review Materials 5 (2020) 730–747
F.H. Silver et al. / Journal of Biomechanics 36 (2003) 1529–1553

FRAMEWORK FOR MANUFACTURING HETEROGENOUS BIOMATERIALS

Natural Materials	Photoinitiators
Collagen I, II, III, IV, etc.	Irgacure 2959
Hyaluronan	Riboflavin
Gelatin	Rose Bengal
Elastin	
Fibronectin	

CONVERGENCE

DESIRED PRODUCT

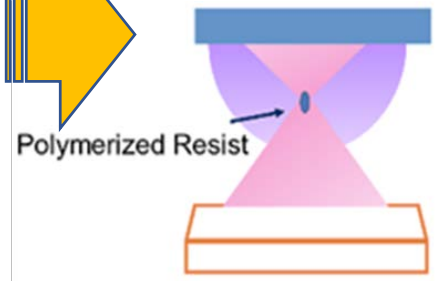


MATERIALS DATABASE, PROCESSES

DESIGN & MODELING PROCESS

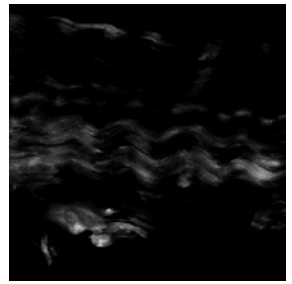
PROCESS

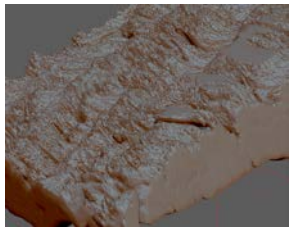
Two-Photon Lithography



INITIAL PRODUCT

END PRODUCT





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MACHINE LEARNING

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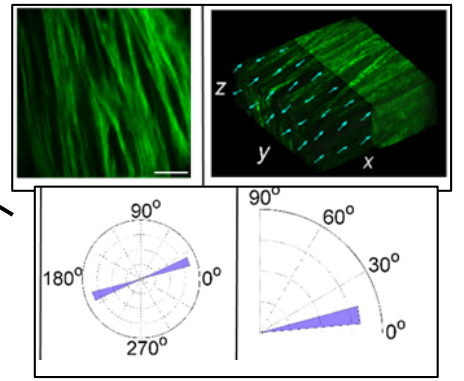
ADVANCED METROLOGY & BIOLOGICAL VALIDATION



- Requires convergence of disciplines
- Utilize smart manufacturing framework

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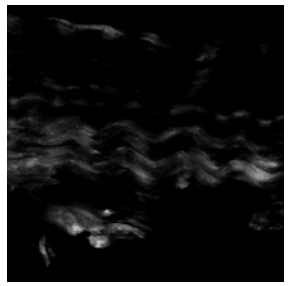
Sci Rep 11, 324 (2021)

DEMOCRATIZING THE BIOMANUFACTURING PROCESS



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DATA REPOSITORY

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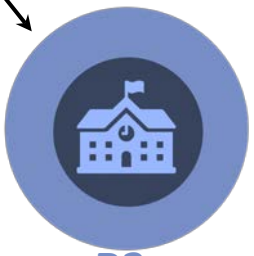
R1

MSI

COMMUNITY COLLEGE

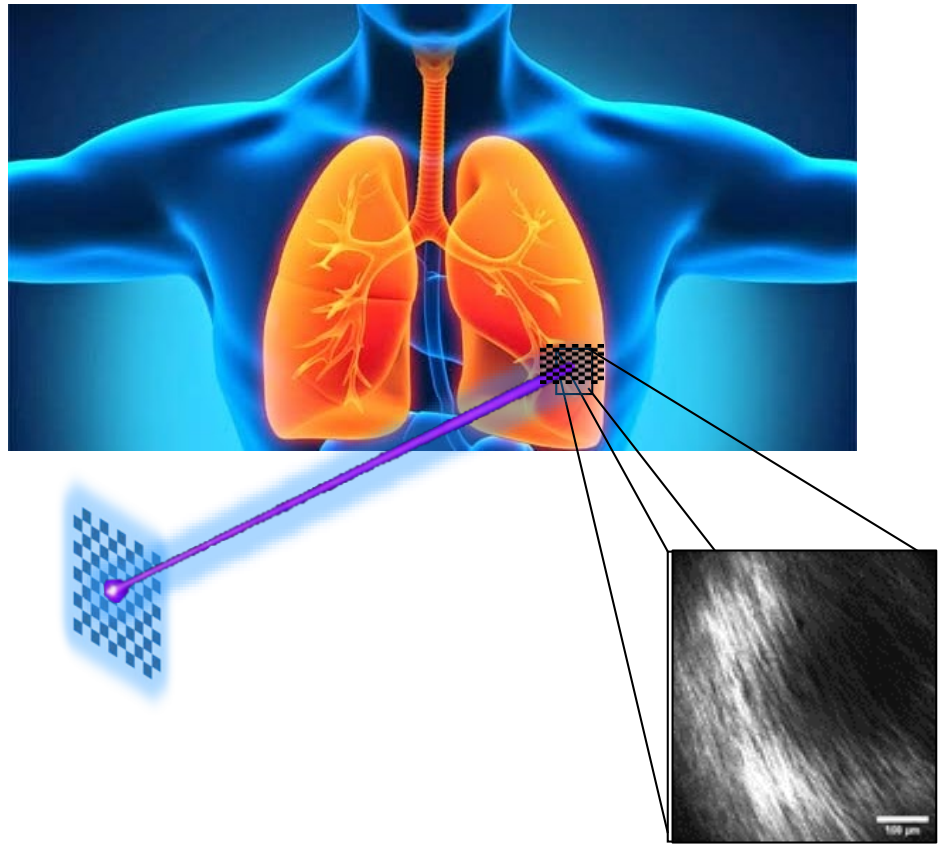


R2

- Towards scalability
- Facilitates development of a diverse and inclusive biomanufacturing ecosystem
- Expands biomanufacturing research enterprise (modeling, experiments)

KNOWLEDGE GAPS & TECHNOLOGICAL NEEDS

- Small footprint, ultrafast lasers with dynamic wavefront shaping
- Multiscale (and Multiphysics) modeling for complex, heterogenous biomaterials
- New biomaterials and biocompatible and water soluble photoinitiators



Courtesy: A. Howes (M. Dawson Lab, Brown U.)