SOUTH CAROLINA PROJECT

WHAT IS IT?

Statewide Effort
That Would Be Competitive For
National Science Foundation
Research Infrastructure Improvement Award

NSF RII “S.C. PROJECT”

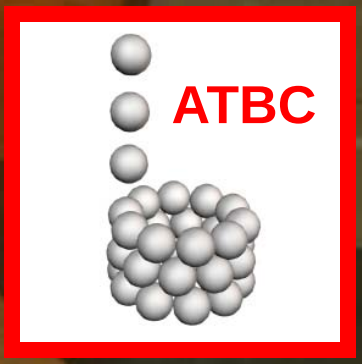
SOUTH CAROLINA PROJECT

WHAT IS IT?

BIOFABRICATION PROJECT

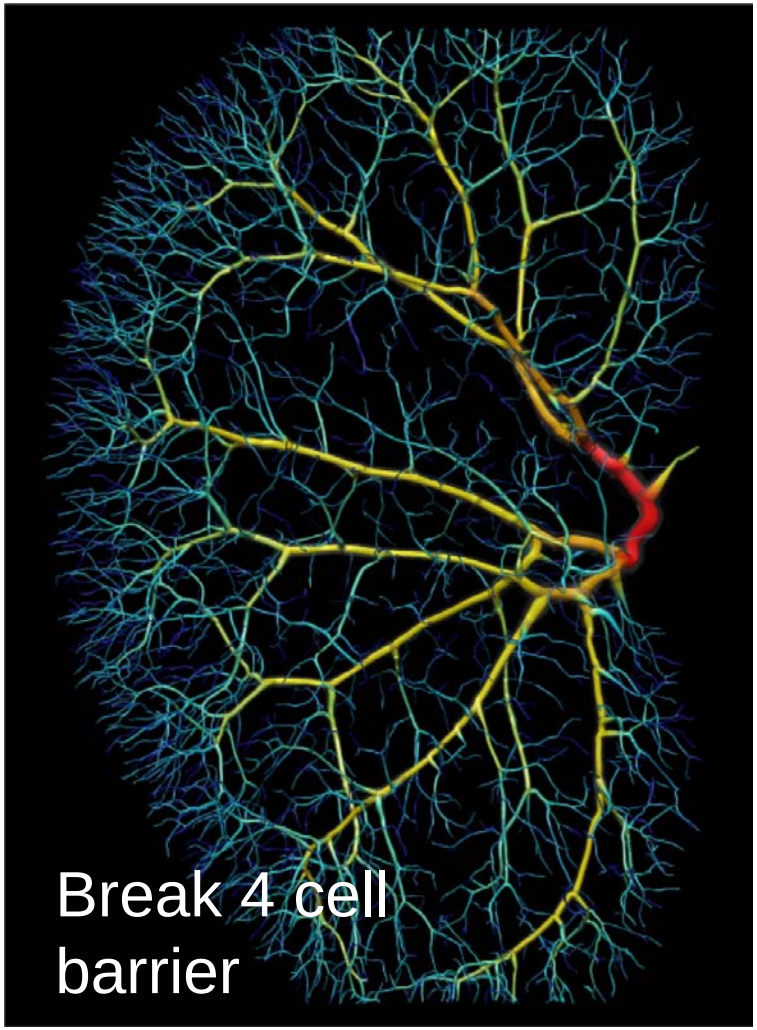
To Engineer
A Vascular Tree By Bioprinting

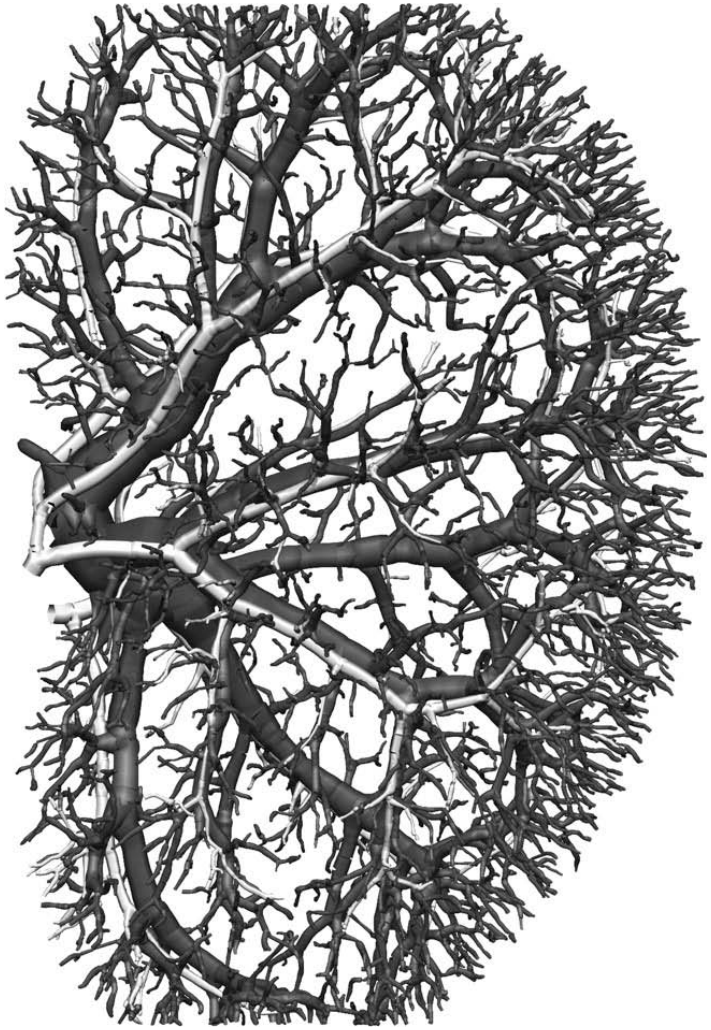
What is Bioprinting?



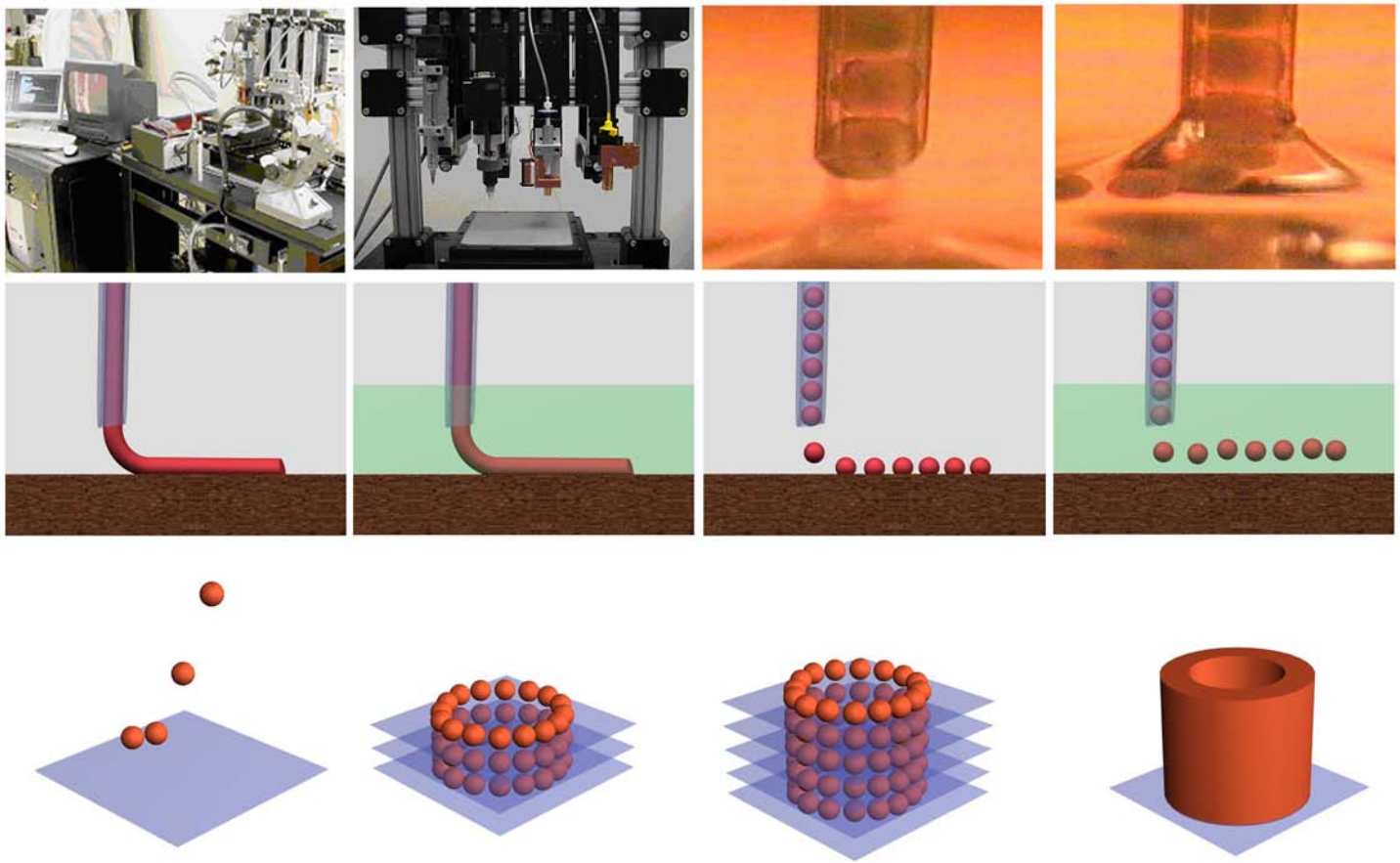
Bioprinting/Biofabrication is a computer-aided, robotic layer by layer addition of living building blocks to form 3D functional human tissue constructs

Future of tissue and organ biofabrication will depend upon first engineering a functional vascular tree

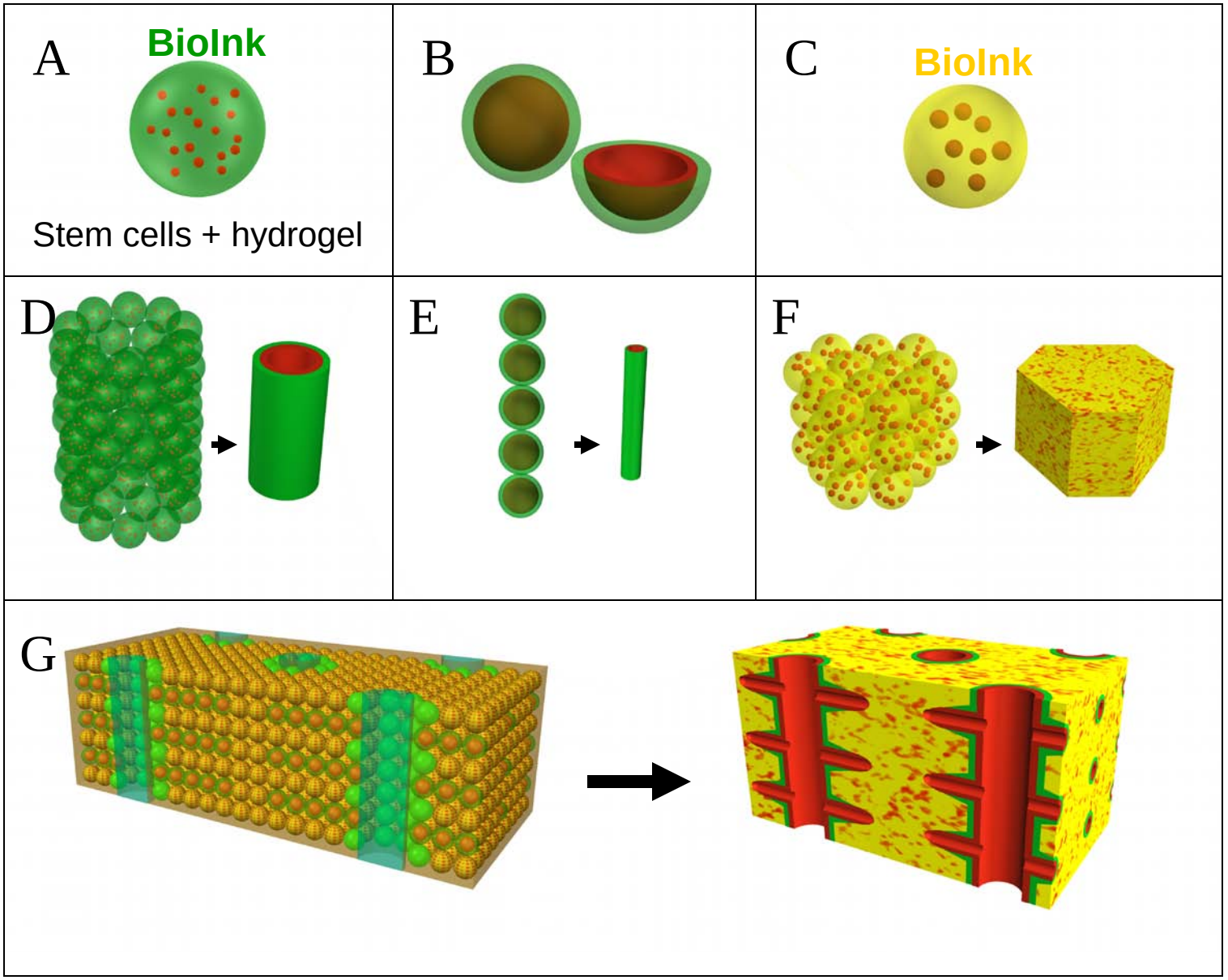




BioPrinting Using “BioInk”

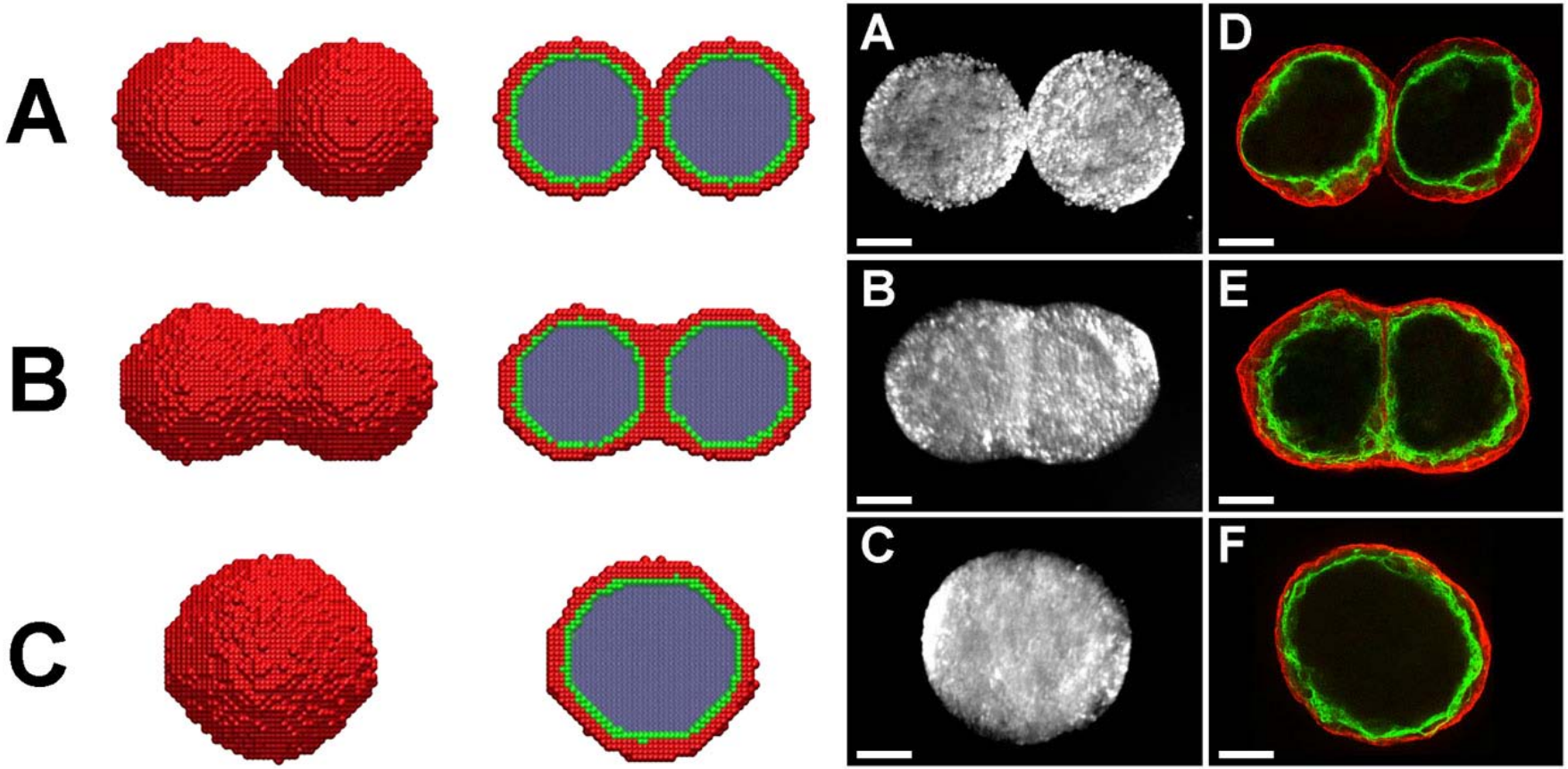


BioInk = aggregates of stem cells + hydrogel (morphogens)



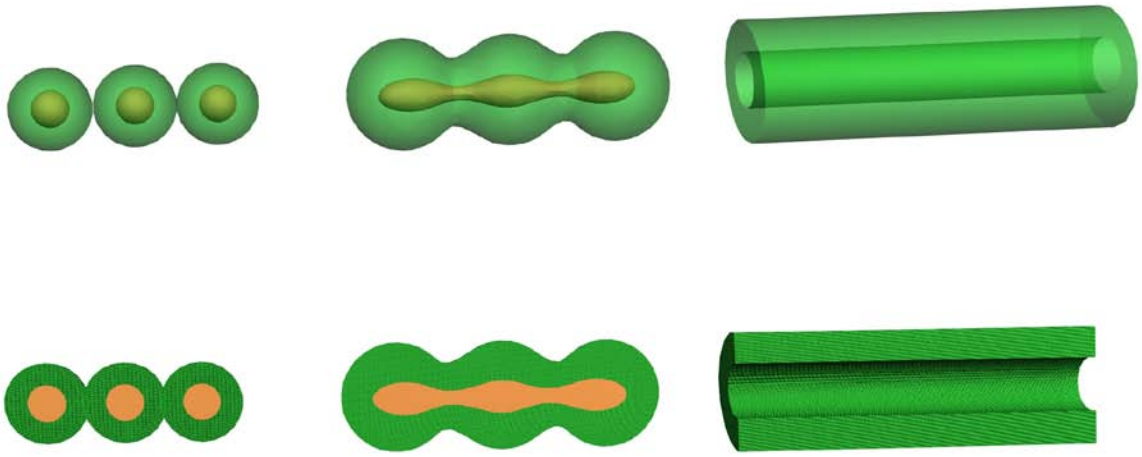
From Mironov, Markwald et al 2009 in *Expert Opinion in Biological Therapy (in press)*

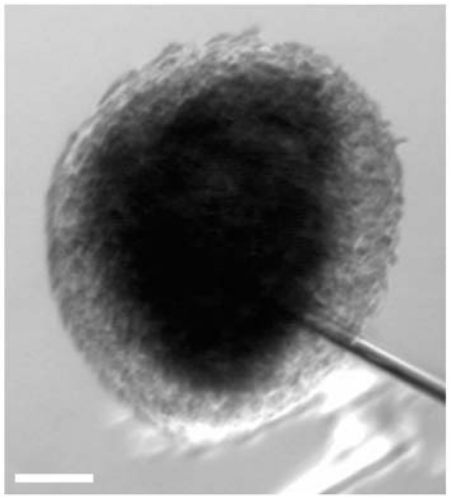
Vascular Tissue Spheroids Fusion

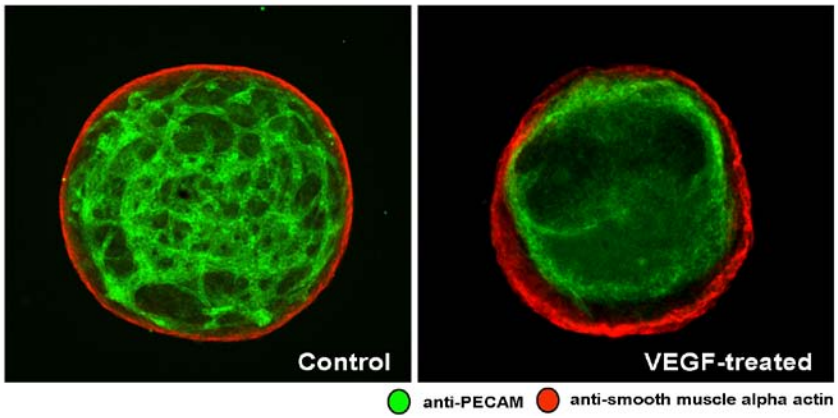


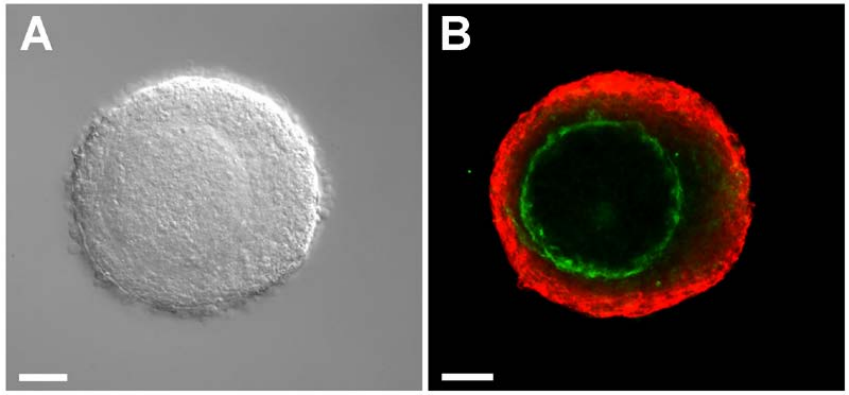
Malcolm Steinberg's Differential Adhesion Hypothesis

Vascular Tissue Spheroids

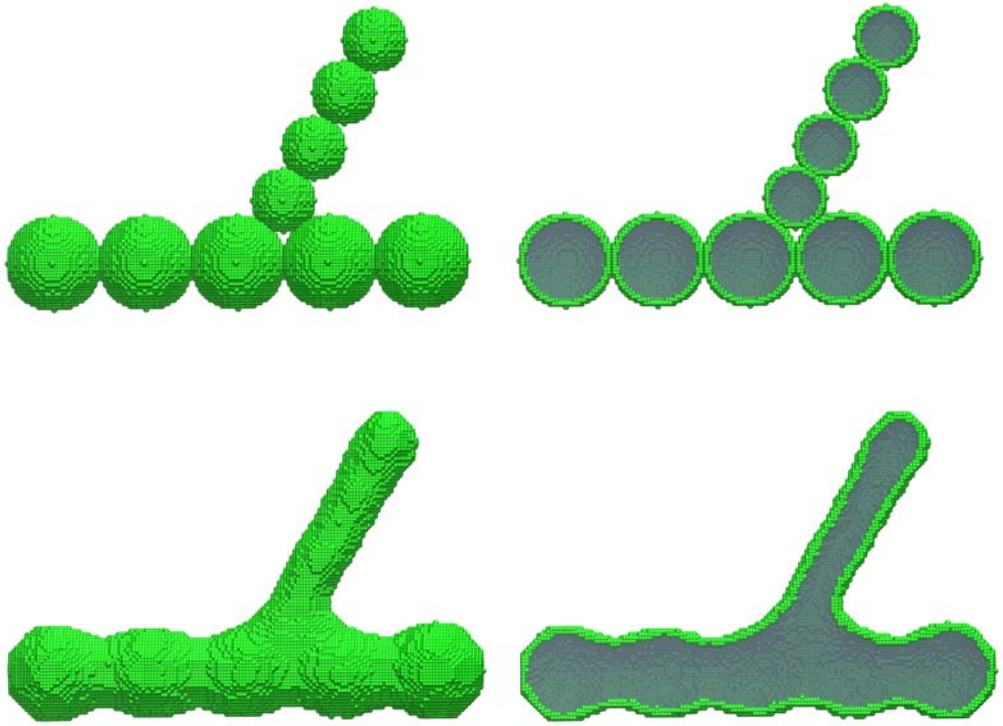


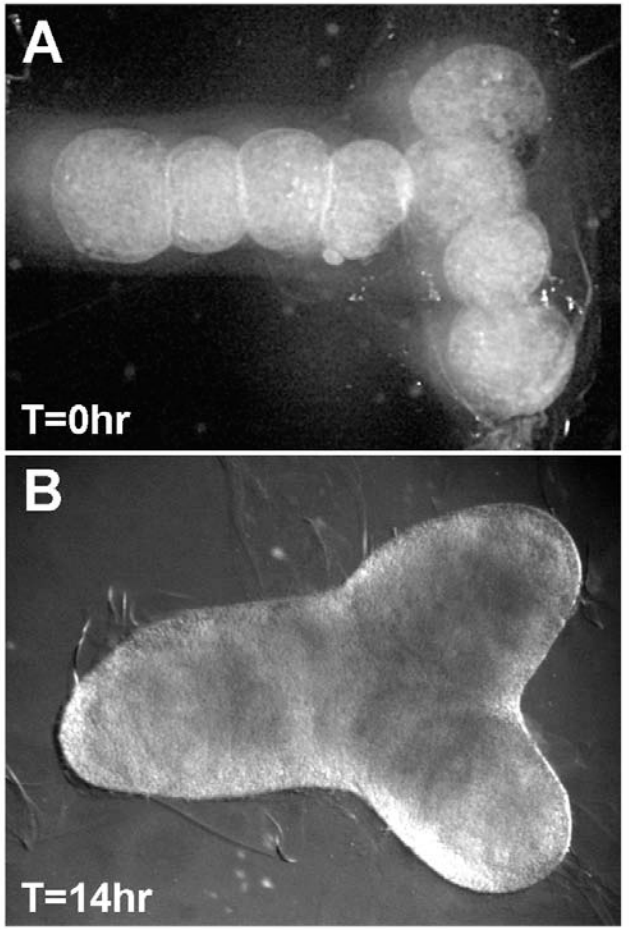




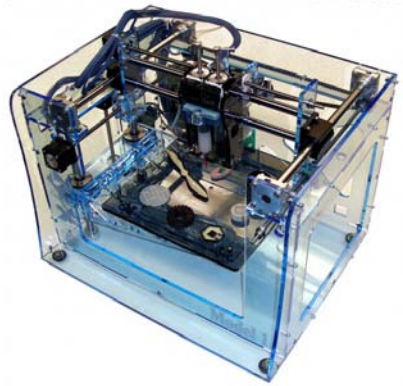


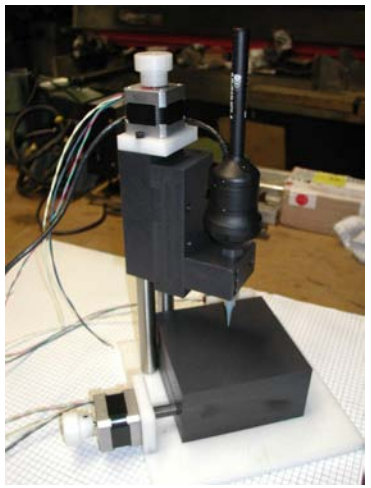
Vascular tissue spheroids fusion





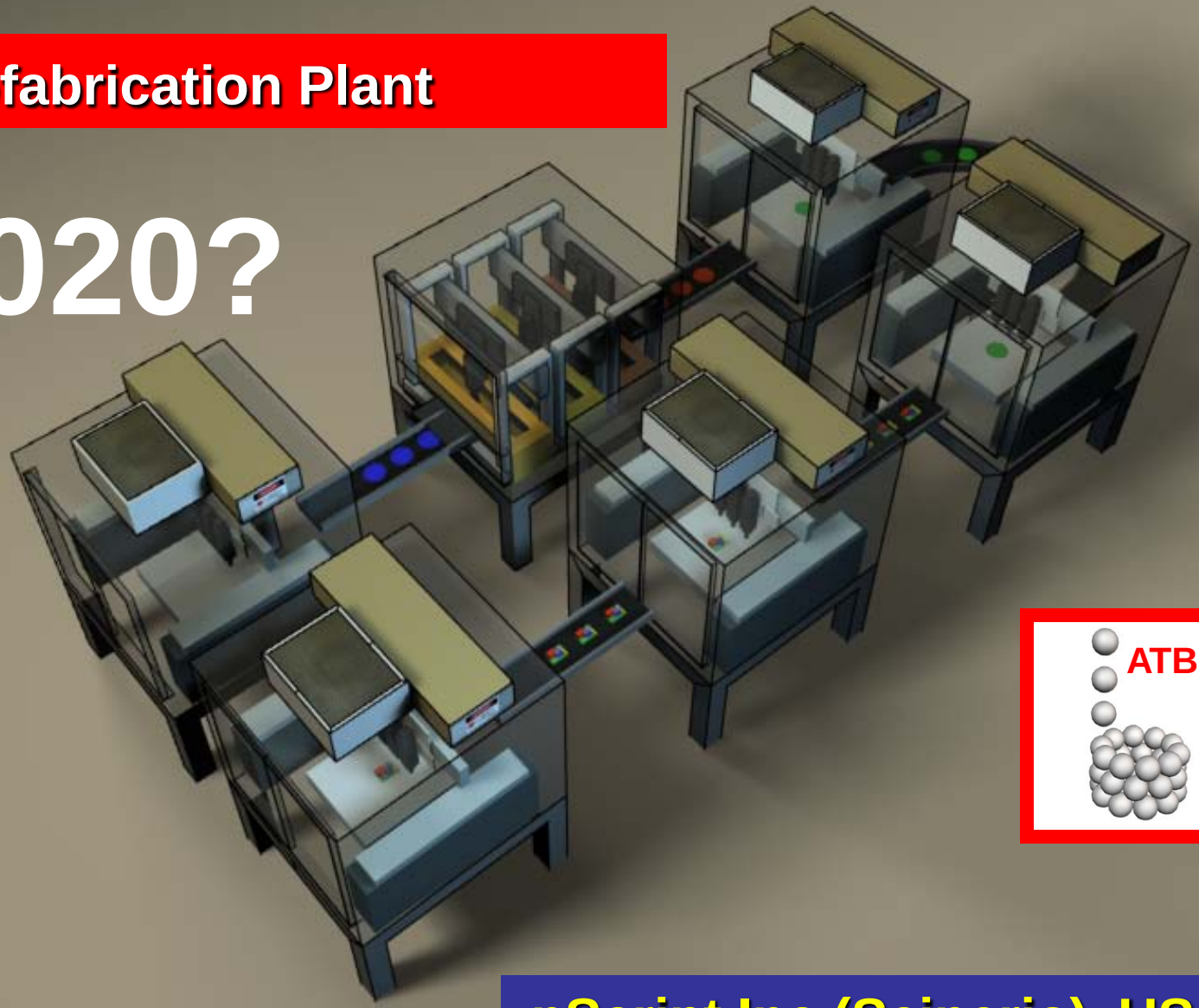
Rapidly Growing Family of Industrial Bioprinters





Biofabrication Plant

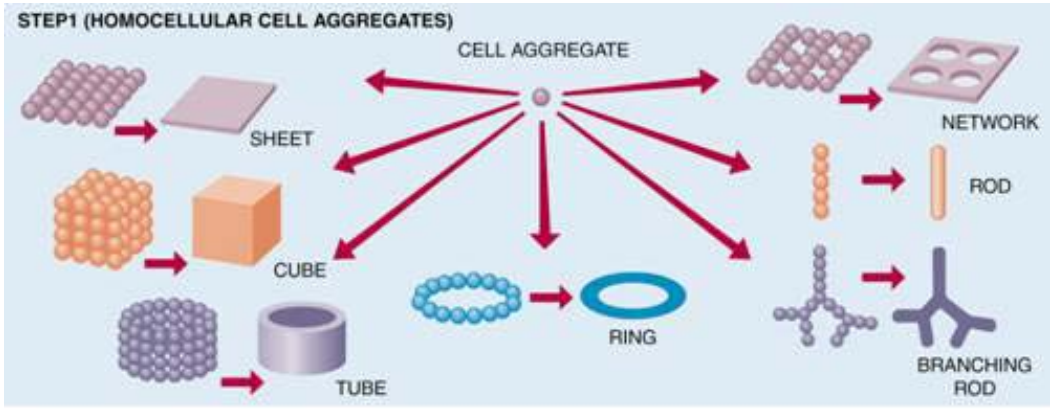
2020?



nScript Inc.(Sciperio), USA

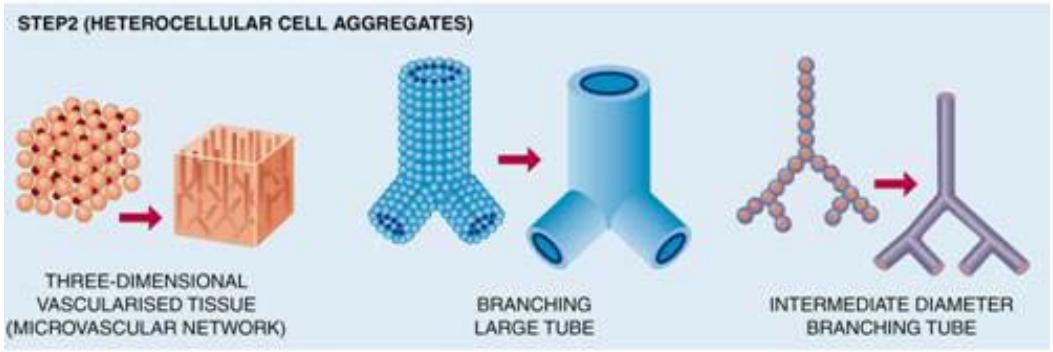
Road Map & Timeline

2003



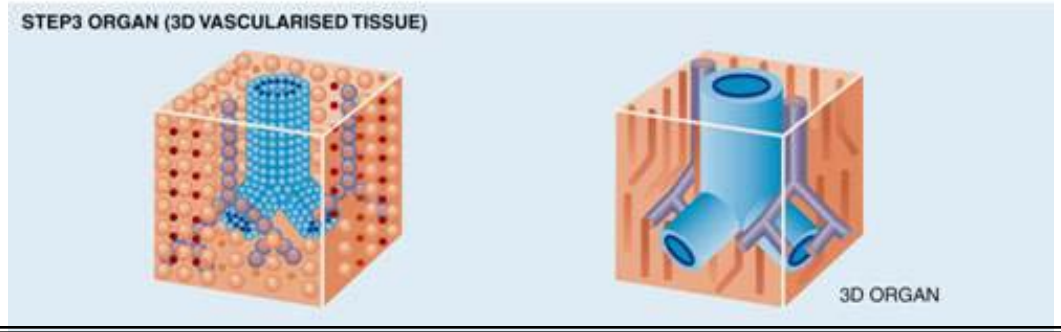
Building blocks= Aggregates

2009



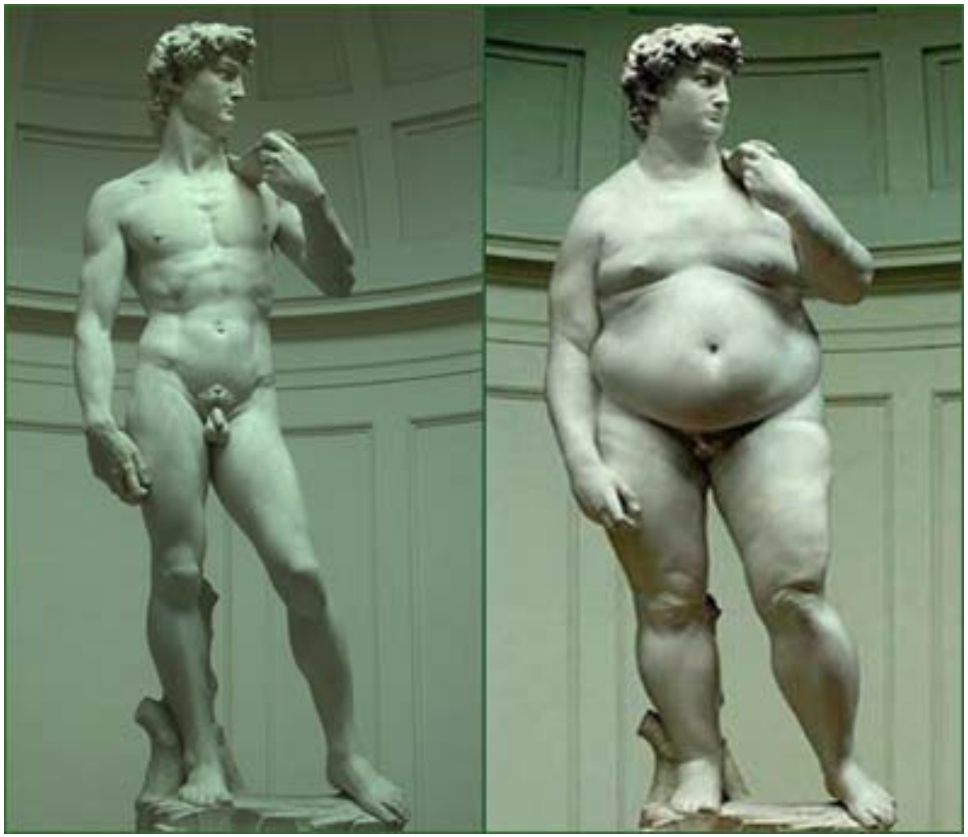
Each 100K+ cells

2020



STEM CELL - based

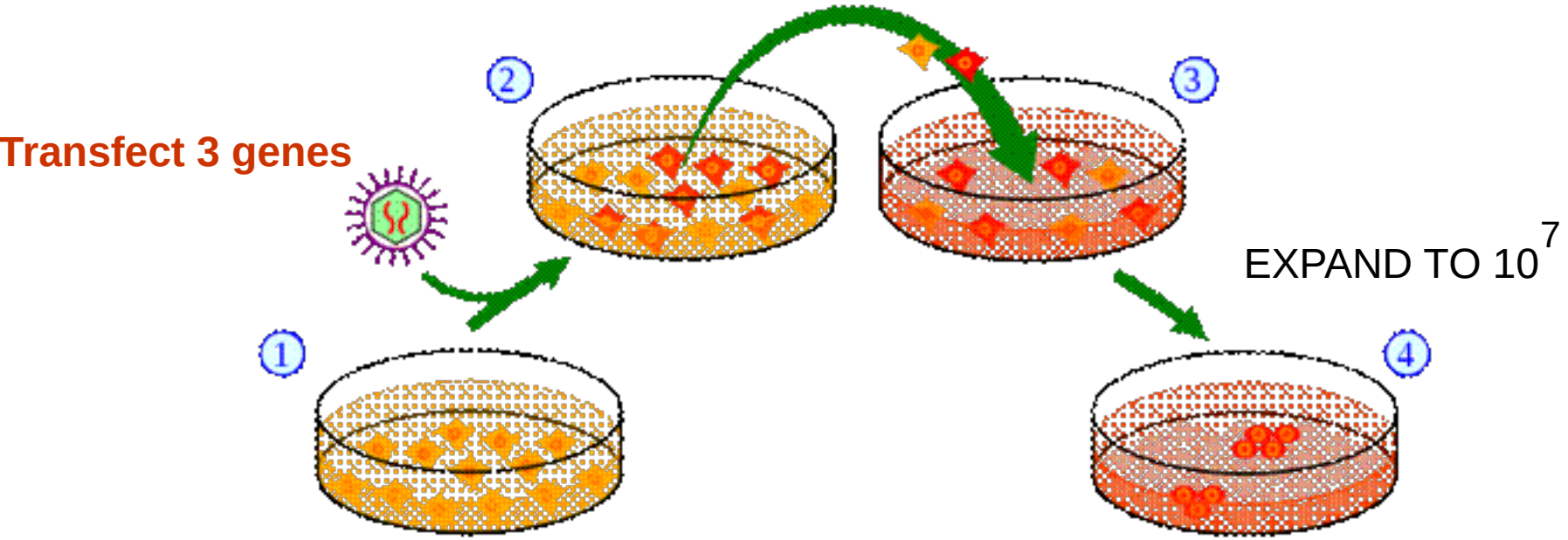
Fat Tissue Derived Stem Cells



Celution™ System

Technology for isolating large scale numbers of stem cell from adipose tissue

Generation of induced pluripotent (iPS) cells



ADULT HUMAN SKIN CELLS

Anatomical Imaging

CAD

Components of Organ Printing Technology

Blueprint

I. Pre-processing

Bioink

Biopaper

Bioprinter

II. Processing

MATUROGENS

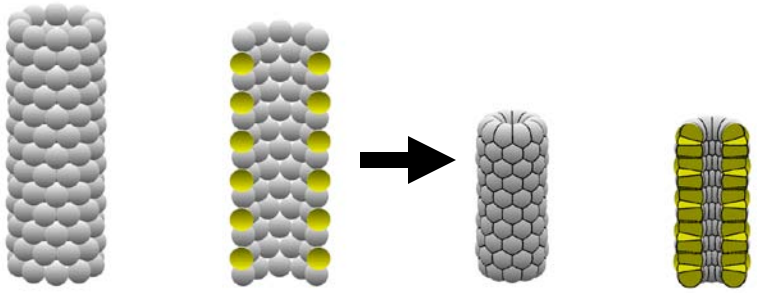
Biomonitoring

Bioreactor

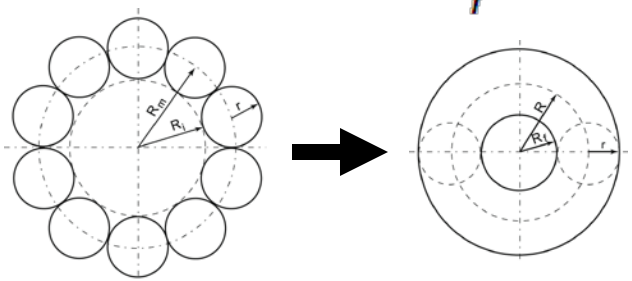
III. Post-processing

3 Steps in Bioprinting

SC Project: “Bioprinting of Vascular Tree”

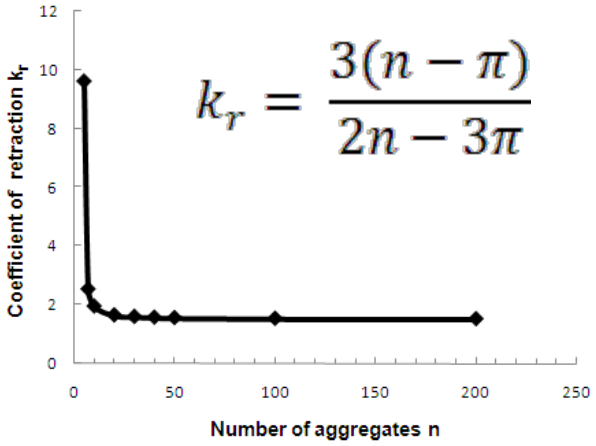


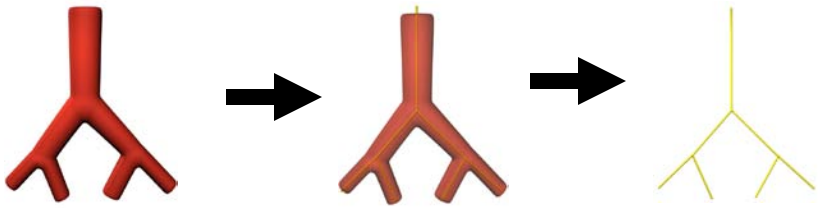
$$n = \frac{1.5\pi(R_f + r)}{r}$$



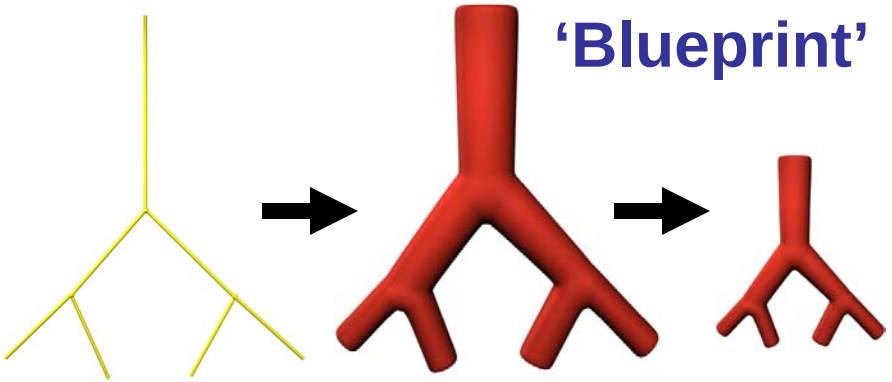
‘Surface Evolver’, Ken Brakke

$$k_r = \frac{3(n-\pi)}{2n-3\pi}$$





‘Blueprint’



Virtual and Physical Prototyping, 2009

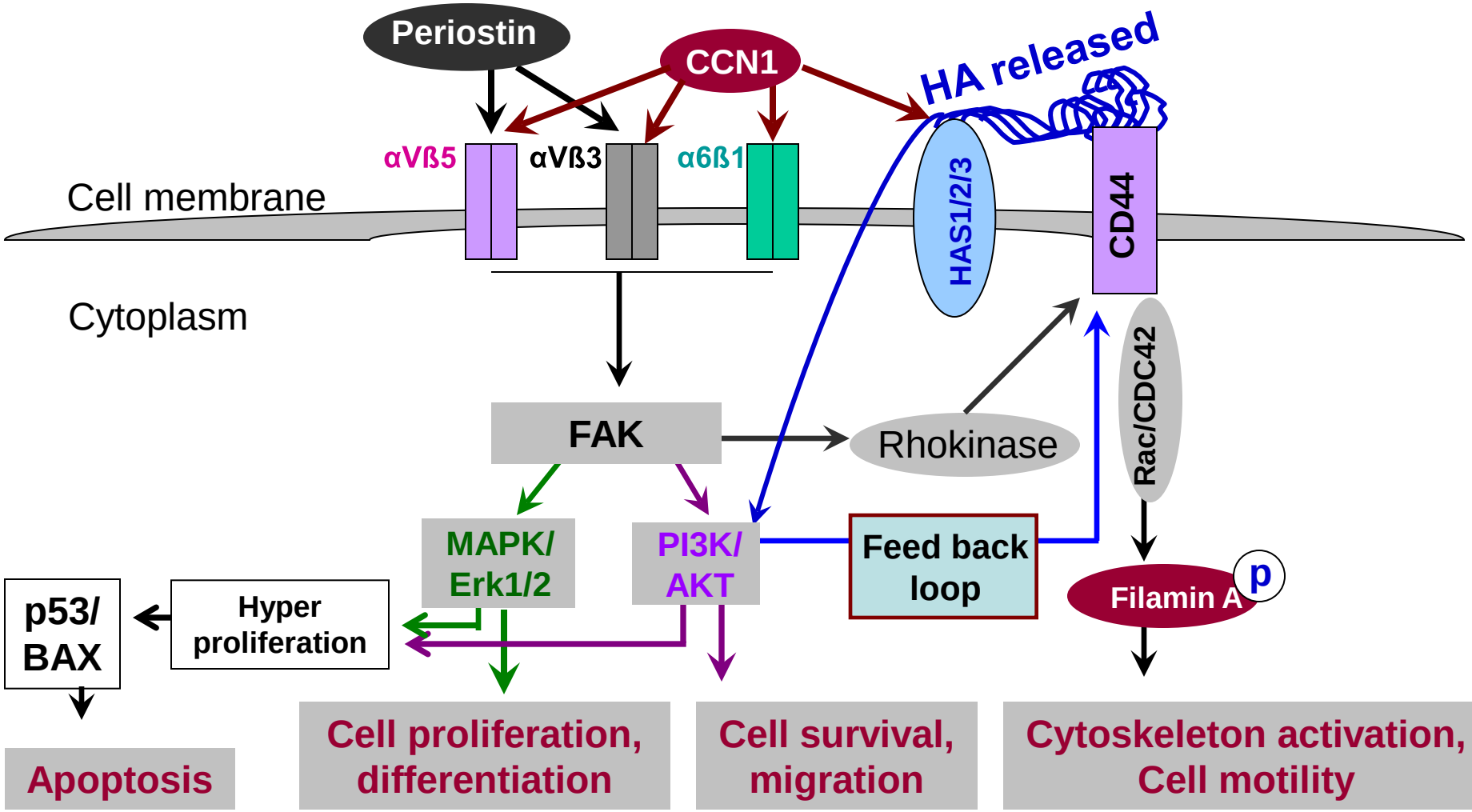
MATUROGENS?

MATRICELLULAR PROTEINS ARE CANDIDATE MATUROGENS

Modular Proteins (multiple domains)

Bind ECM Proteins (e.g. collagen, elastin)

Activate intracellular kinase activity through integrin/filamin-A binding


Periostin
CCN1
HA released
αVß5
αVß3
α6ß1
Cell membrane
HAS1/2/3
CD44
Cytoplasm
FAK
Rhokinase
Rac/CDC42
MAPK/
Erk1/2
PI3K/
AKT
Feed back
loop
Filamin A
p
p53/
BAX
Hyper
proliferation
Apoptosis
Cell proliferation,
differentiation
Cell survival,
migration
Cytoskeleton activation,
Cell motility

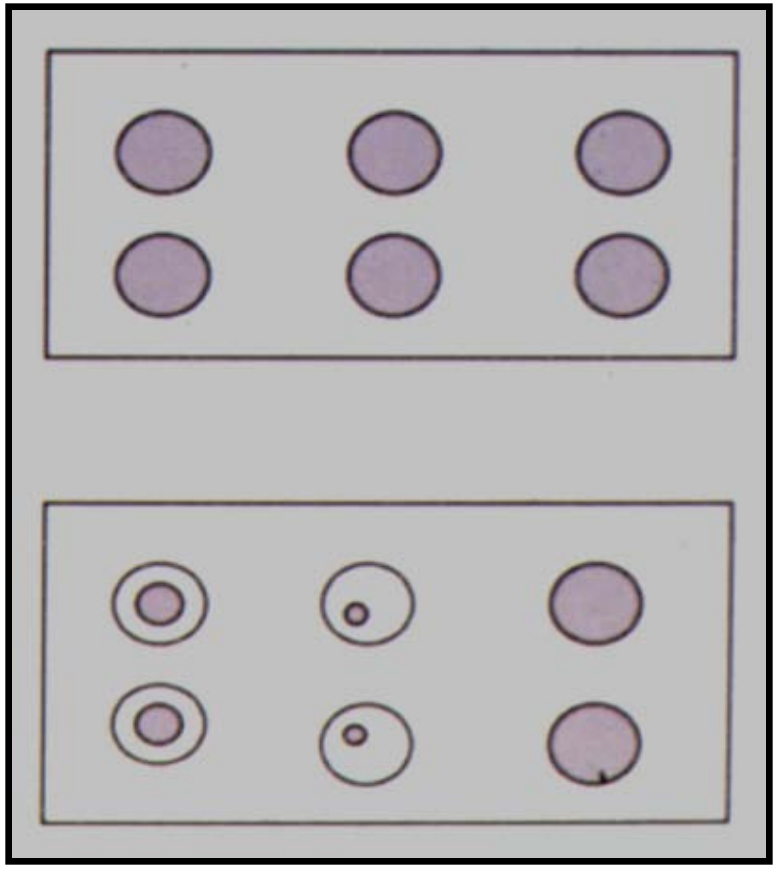
Collagen Gel Contraction/Compaction Assay

50,000 stem cells/ml entombed in neutral collagen gel lattices

infected with Pn αS or Ox virus

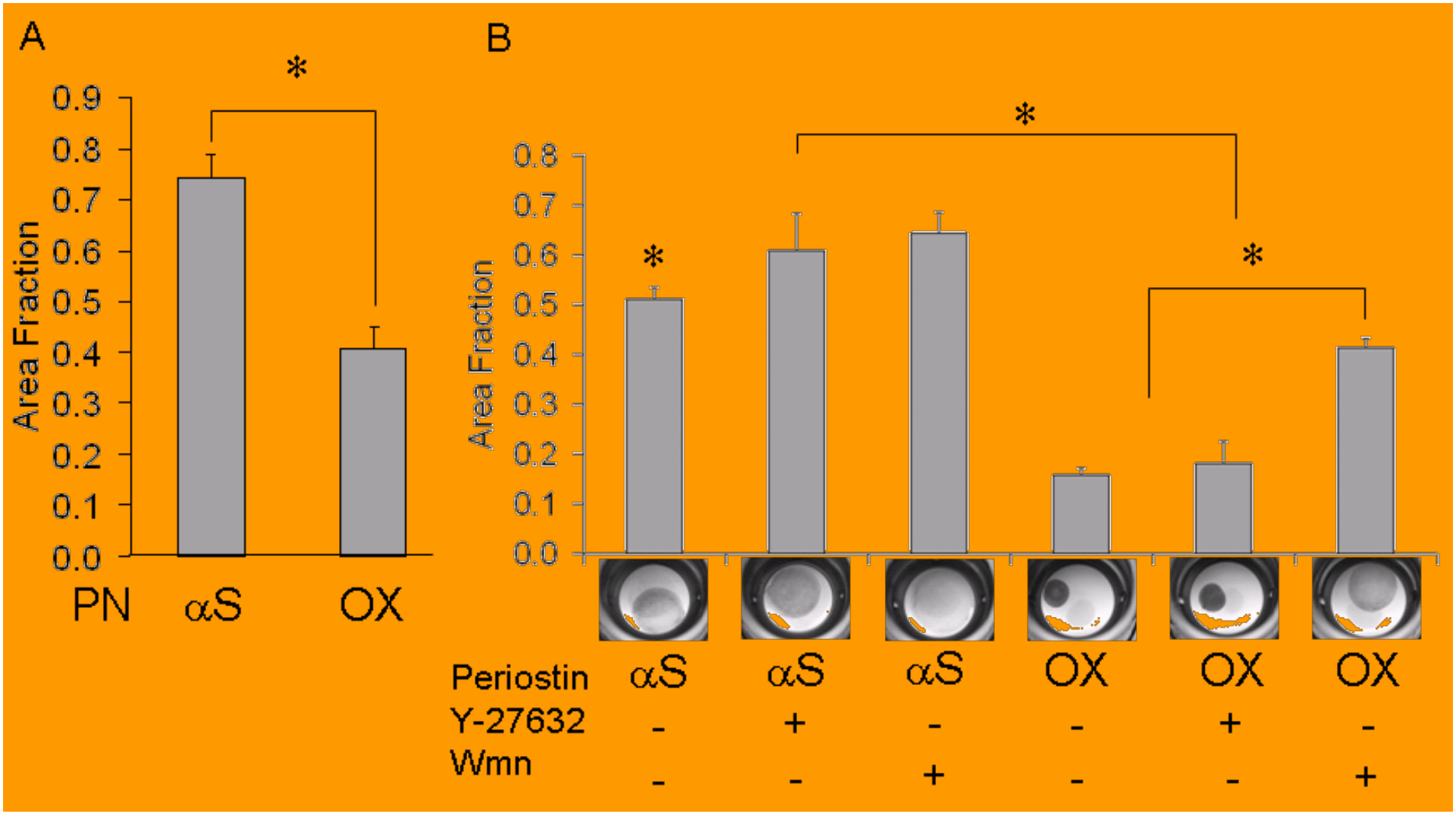
inhibitors of RhoK/*Y27632* and PI3k/*wortmanin* added to medium

Analysis is based on changes in the diameter of gels

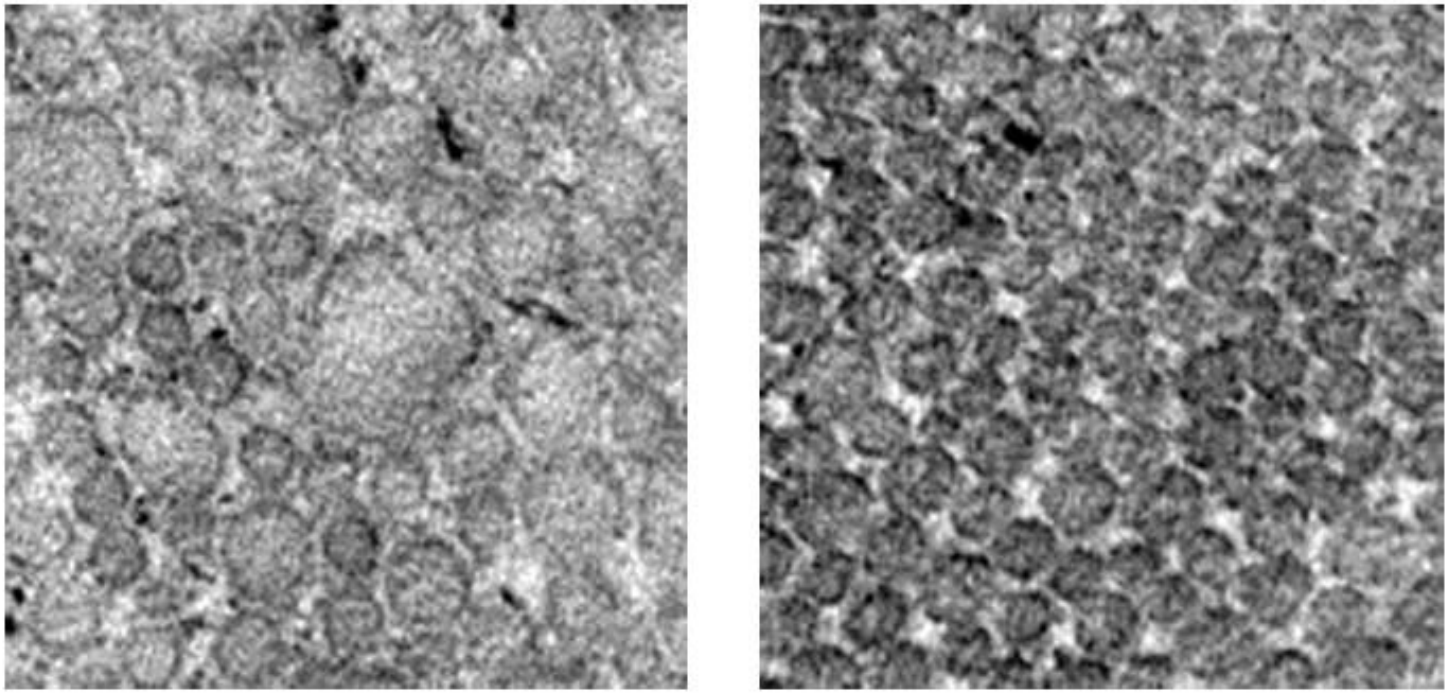


Matricellular Proteins Can Promote Maturation by increasing collagen compaction

Periostin Enhances Collagen Compaction Mediated by PI-3 Kinase



periostin

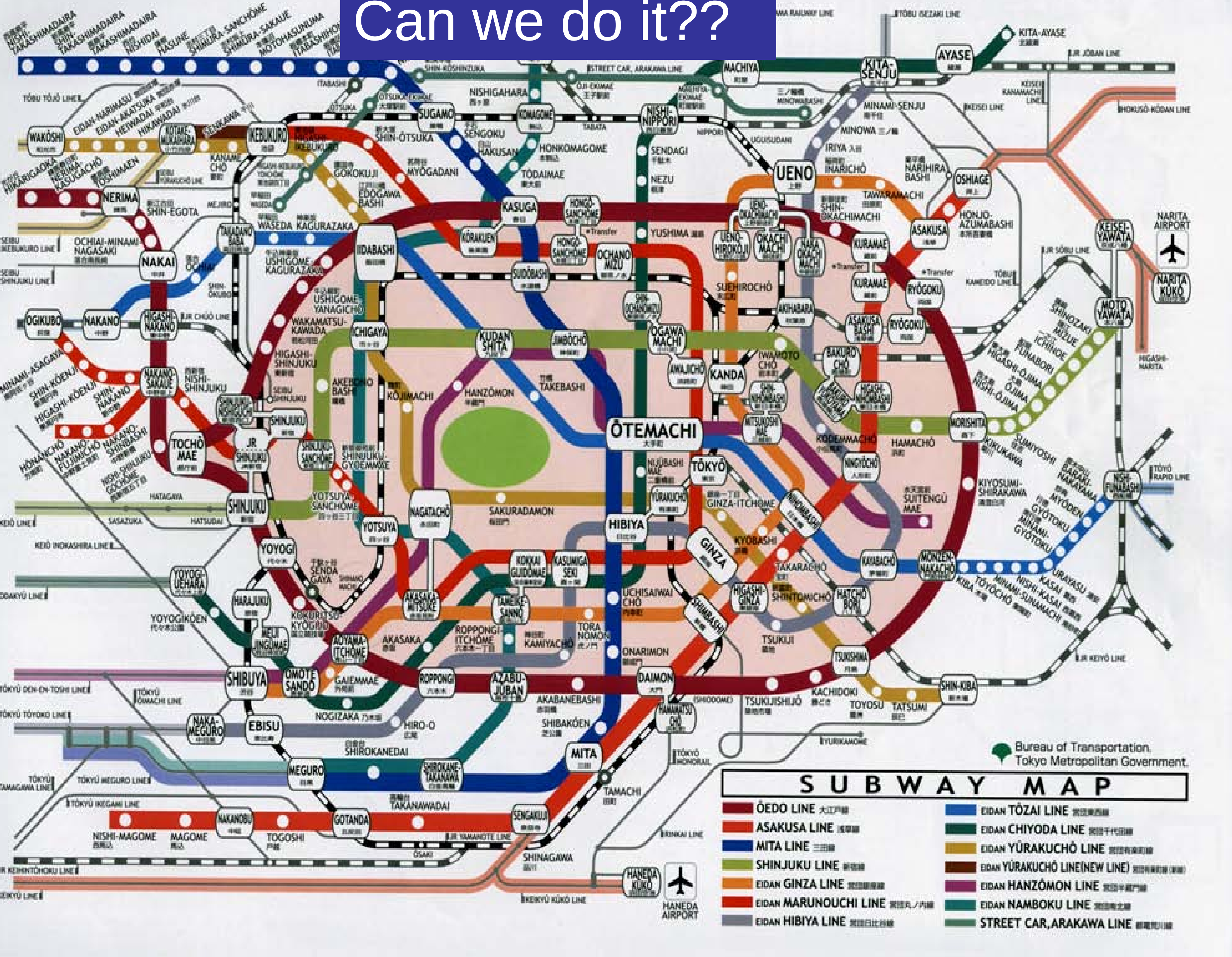


+/+ -/-

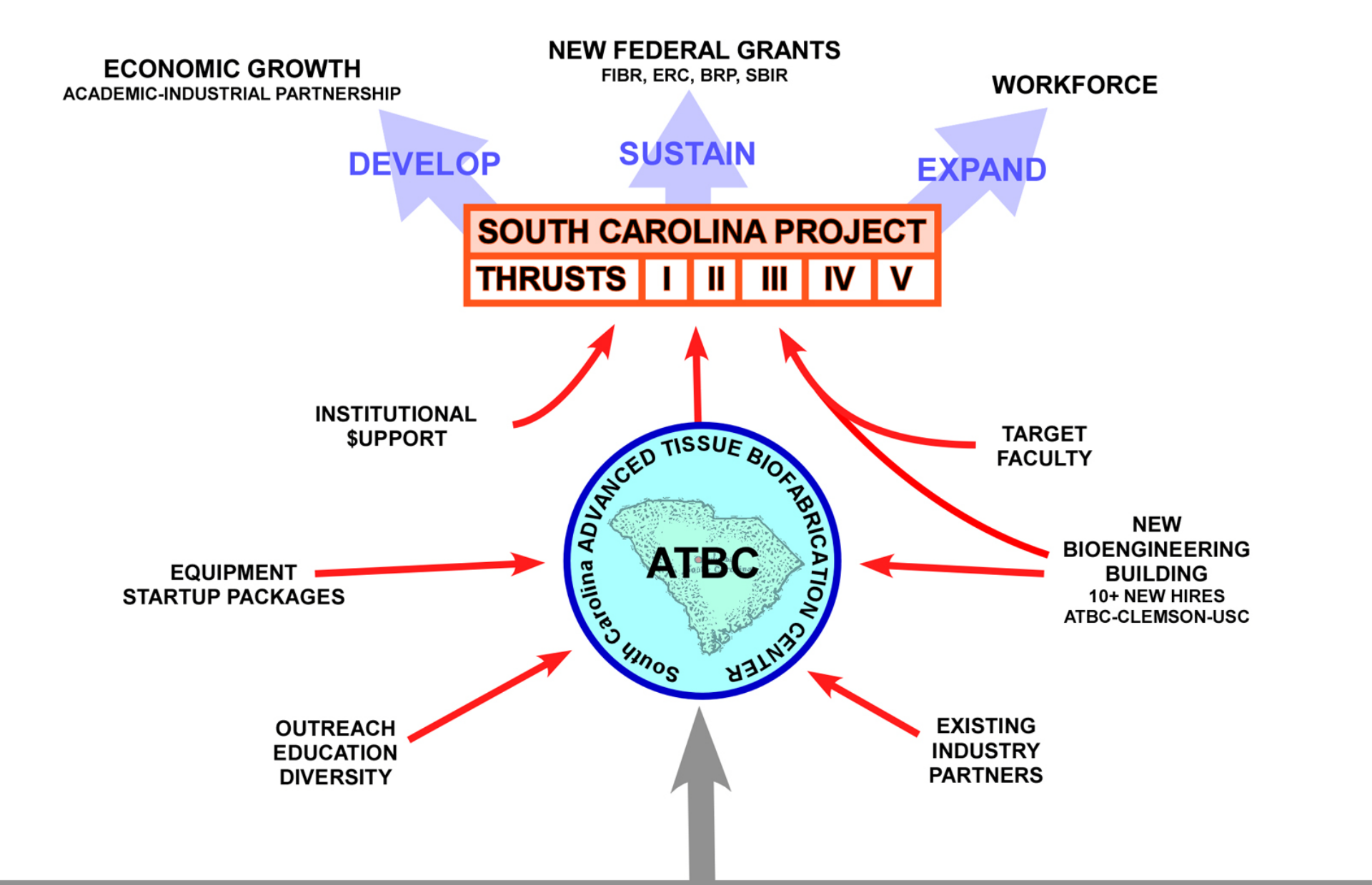
Collagen fibrils

500 nm

Can we do it??



SUBWAY MAP
Bureau of Transportation. Tokyo Metropolitan Government.
ŌEDO LINE
ASAKUSA LINE
MITA LINE
SHINJUKU LINE
EIDAN GINZA LINE
EIDAN MARUNOUCHI LINE
EIDAN HIBIYA LINE
EIDAN TŌZAI LINE
EIDAN CHIYODA LINE
EIDAN YŪRAKUCHŌ LINE
EIDAN YŪRAKUCHŌ LINE(NEW LINE)
EIDAN HANZŌMON LINE
EIDAN NAMBOKU LINE
STREET CAR, ARAKAWA LINE
ŌTEMACHI
UENO
SHINJUKU
SHIBUYA
IKEBUKURO
TŌKYŌ
GINZA
HIBIYA
KASUGA
IIDABASHI
NAKANO
OGIKUBO
EBISU
MEGURO
GOTANDA
MITA
DAIMON
SHIN-KIBA
KITA-SENJU
AYASE
ASAKUSA
OSHIAGE
NISHI-FUNABASHI
NARITA AIRPORT
HANEDA AIRPORT


ECONOMIC GROWTH
ACADEMIC-INDUSTRIAL PARTNERSHIP
NEW FEDERAL GRANTS
FIBR, ERC, BRP, SBIR
WORKFORCE
DEVELOP
SUSTAIN
EXPAND
SOUTH CAROLINA PROJECT
THRUSTS I II III IV V
INSTITUTIONAL $UPPORT
TARGET FACULTY
South Carolina ADVANCED TISSUE BIOFABRICATION CENTER
ATBC
EQUIPMENT STARTUP PACKAGES
NEW BIOENGINEERING BUILDING
10+ NEW HIRES
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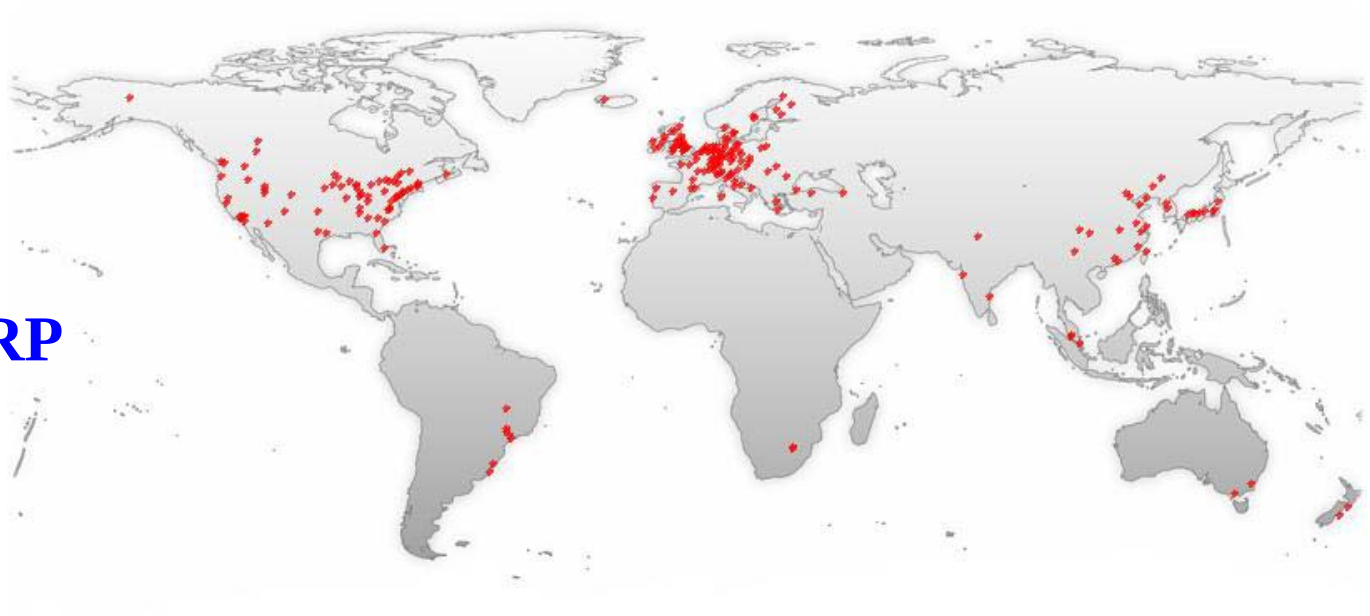
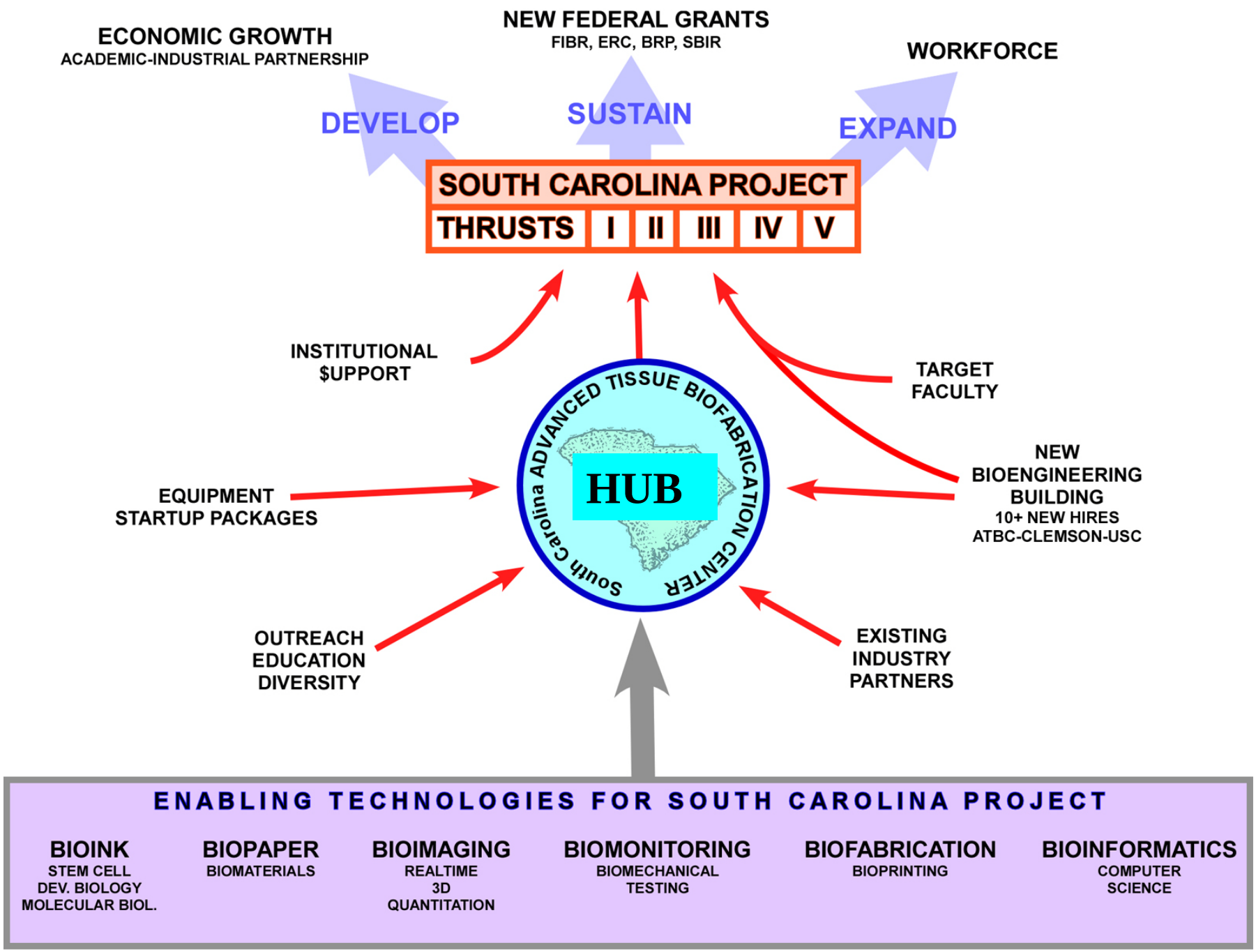
BIOINK
STEM CELL
DEV. BIOLOGY
MOLECULAR BIOL.
BIOPAPER
BIOMATERIALS
BIOIMAGING
REALTIME
3D
QUANTITATION
BIOMONITORING
BIOMECHANICAL
TESTING
BIOFABRICATION
BIOPRINTING
BIOINFORMATICS
COMPUTER
SCIENCE

RP



RP in TE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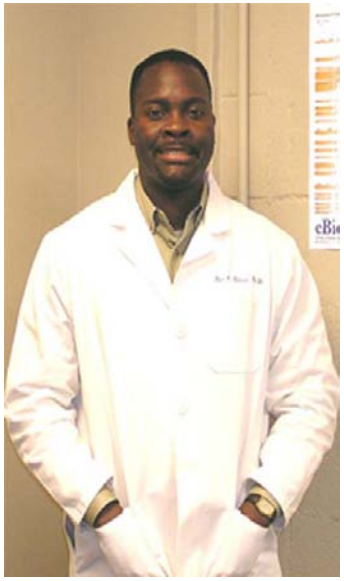
Education and Diversity Program



Program Director
Dr. Titus Reaves

1. The Annual Ernest Just Symposium: African-Americans in Biomedical Sciences

2. Support Development Educational Outreach Programs

3. Economic and business expertise

Charleston born
Dr. Ernest E. Just

“There is no such thing as a science fiction. There is only science eventuality.”

Prof. Krummel

Stanford University, CA, USA