



# HOW ADDITIVE MANUFACTURING IS CHANGING HEALTHCARE

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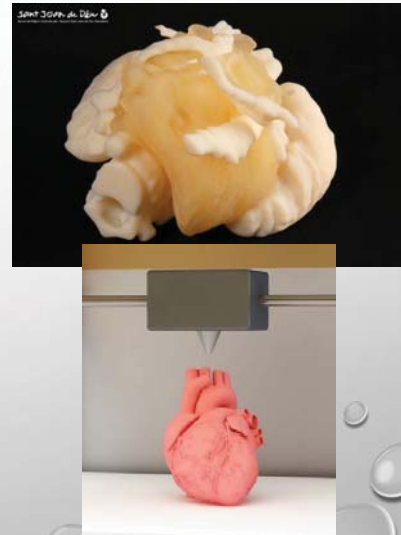


## AREAS OF USE

- AM MODELS FOR SURGICAL SIMULATION AND TRAINING
- AM FOR TISSUE ENGINEERING AND REGENERATIVE MEDICINE
- AM FOR DENTAL IMPLANTS
- AM FOR ORTHOPEDIC IMPLANTS
  - CUSTOM
  - TRADITIONAL
- AM FOR PROSTHETIC DEVICES
  - EXTREMITIES, EXTERNAL & INTERNAL FIXATION
  - BRACES & ORTHOTICS
- AM FOR ANAPLASTOLOGY
- AM FOR PERSONALIZED DRUGS
- AM FOR PRINTING OF MEDICAL SENSORS

## STATE-OF-THE-ART IN BASIC AM RESEARCH FOR HEALTH

- SURGICAL SIMULATION MODELS
  - USE OF HIGH RESOLUTION MEDICAL IMAGING TO CAPTURE TRUE ANATOMY
    - MULTI MODALITIES, PATIENT SPECIFIC CASES,
  - USE OF MULTI-MATERIAL 3D PRINTERS TO PROVIDE MORE REALISTIC MODELS
  - USE OF 3D PRINTED MOLDS TO CAST MODELS WITH MORE REALISTIC PROPERTIES
    - SAWBONES REPLACEMENT
- TISSUE ENGINEERING AND REGENERATIVE MEDICINE
  - OPTIMIZATION OF SCAFFOLD DESIGN AND PRINTING PARAMETERS
  - BIODEGRADABLE MATERIALS AND DEVICES
  - TISSUE RESPONSES TO AM STRUCTURES



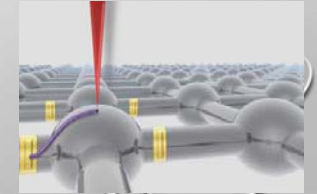
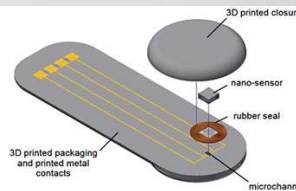
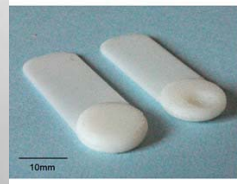
## STATE-OF-THE-ART IN BASIC AM RESEARCH FOR HEALTH

- DENTAL IMPLANTS
  - CUSTOM CROWNS, BRIDGES, IMPLANTS
  - CUSTOM BRACES, MODELS FOR PLANNING,
- ORTHOPEDIC IMPLANTS
  - JOINTS, REPLACEMENTS, SPINE
- PROSTHETIC DEVICES
  - BRACES, LIMBS, COVERS



# STATE-OF-THE-ART IN BASIC AM RESEARCH FOR HEALTH

- PERSONALIZED DRUGS
  - IN THE WORKS FOR A WHILE
- AM PRINTING OF MEDICAL SENSORS AND ELECTRONICS
  - IN VIVO, EX VIVO
  - IMPLANTS AND TISSUES
- ANAPLASTOLOGY
  - 3D PRINTED MOLDS
  - DIRECT PRINTING



# FUTURE PROSPECTS OF AM IN HEALTH

- ON-DEMAND SURGICAL MODELS FOR EMERGENCY CASES
- STREAMLINED AM IMPLANT DESIGN AND FABRICATION
- MORE CUSTOMIZABLE DEVICES AND SURGICAL TOOLS
- COMBINATION OF METAL IMPLANT STRUCTURES AND TISSUE ENGINEERING
- CUSTOM AM SMART IMPLANTS AND DEVICES



## FUNDING FOR AM IN HEALTH

- NSF
  - ENGINEERING FOCUSED MEDICAL AM RESEARCH
  - PROCESSES, DESIGN, FABRICATION, EQUIPMENT, MATERIALS
- NIH
  - NARROW MEDICAL RESEARCH QUESTIONS FOR AM
  - BIOLOGICAL RESPONSES, CELL LEVEL
- DOD
  - MEDICAL AM RESEARCH FOR MILITARY AND COMBAT INJURIES
  - PRACTICAL SOLUTIONS, SHORTER RECOVERY,
- NASA
  - MEDICAL AM RESEARCH TO SUPPORT SPACE EXPLORATION



## IDENTIFICATION OF NEEDS, GAPS, AND CHALLENGES

- BETTER UNDERSTANDING OF MATERIAL PROPERTIES AND MATERIAL BEHAVIOR
- EASIER FINISHING OF METAL COMPONENTS
- MORE RELIABLE 3D PRINTERS WITH FEEDBACK
- BETTER DESIGN TOOLS FOR COMPLEX GEOMETRIES INCLUDING FEA
- HIGHER RESOLUTION OF MEDICAL IMAGING

## RECOMMENDATION FOR BASIC RESEARCH INITIATIVES

- IN VIVO 3D PRINTING OF STRUCTURES, DEVICES AND SENSORS
- OPTIMIZED DESIGN FOR SCAFFOLDS PRINTING
- MATERIAL DEVELOPMENT FOR MEDICAL IMPLANTS AND DEVICES
  - BIOCOMPATIBLE
  - BIODEGRADABLE
- FATIGUE BEHAVIOR AND MODELING OF CUSTOM LOW-MODULUS IMPLANTS AND STRUCTURES

