Additive Manufacture for Tissue Engineering

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Overview

- Tissue engineering and scaffolds
- Additive manufacture
- Additive manufacture of scaffolds
- Future work
A range of possibilities for how tissue engineering might work

A simpler picture

Create scaffold in biomaterial

Regenerate new tissue

Seed with cells (or proteins, or not at all)

Implant
Resorbable Scaffolds

- Needs:
  - Bioactive: able to resorb at a similar rate to that at which the natural tissue grows
    - bioceramics, biopolymers, and polymer-ceramic biocomposites the starting materials
  - Defined topology
    - generally highly porous to support tissue integration, cell transport, nutrient supply
  - Appropriate surface properties and surface chemistry
  - Appropriate mechanical properties

Additive Manufacture

- Make what you want, where you want, when you want

- aka 3D printing, rapid prototyping, layer manufacturing

- Automated manufacture of low volume or one-off components direct from CAD, normally using a layer manufacture technique
Additive Manufacture

Commercial Additive Manufacture Machines

- **High end**
  - > £200k

- **Mid-moderate**
  - £20k – £200k

- **Low cost**
  - £1k - £20k
Personalised Rapid Manufacture

Made by Layerwise in Belgium, implanted in the Netherlands

Z Corp 3D Printing
Combined Macro and Micro Porosity in AW Bioceramic

Fused Deposition Machine (FDM)
FDM of PLA

FDM of PLA Cores for Macroscale Porosity in Sintered AW Bioceramic Scaffolds
FDM of PLA Cores for Macroscale Porosity in Sintered AW Bioceramic Scaffolds

Features:
• Pre-defined channels; with highly porous structured matrix;
• With suitable chemistry for tissue growth – Collagen+ HA
• Controlled degradation rate;
• No toxic solvent involved.

FDM Moulds for Collagen

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SEM Examination

Micro-CT

Future possibilities: in situ repair

Additive manufacturing for in situ repair of osteochondral defects

http://www.spinefracture.org/procedure.html
Future possibilities:
cell and material co-processing

Conclusions

- We can make nearly any shape in nearly any material
- 3D printing techniques can make it easier to make the right shapes, from the right materials, that we need for scaffolds
- Also opens up novel cell/material co-processing and in situ defect repair possibilities
Future Work

Developing subchondral and osteochondral scaffolds for tissue engineering

Future Work

- Developing subchondral and osteochondral scaffolds and maxillofacial bone repair products
- Also specifically evaluating in-clinic production routes
Future Work

- New Centre for Innovative Manufacture in Medical Devices, led by John Fisher at Leeds, in collaboration with Newcastle, Sheffield, Nottingham, Bradford
- Newcastle lead on personalised ‘near patient’ manufacturing processes for implantable musculoskeletal devices

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Questions?