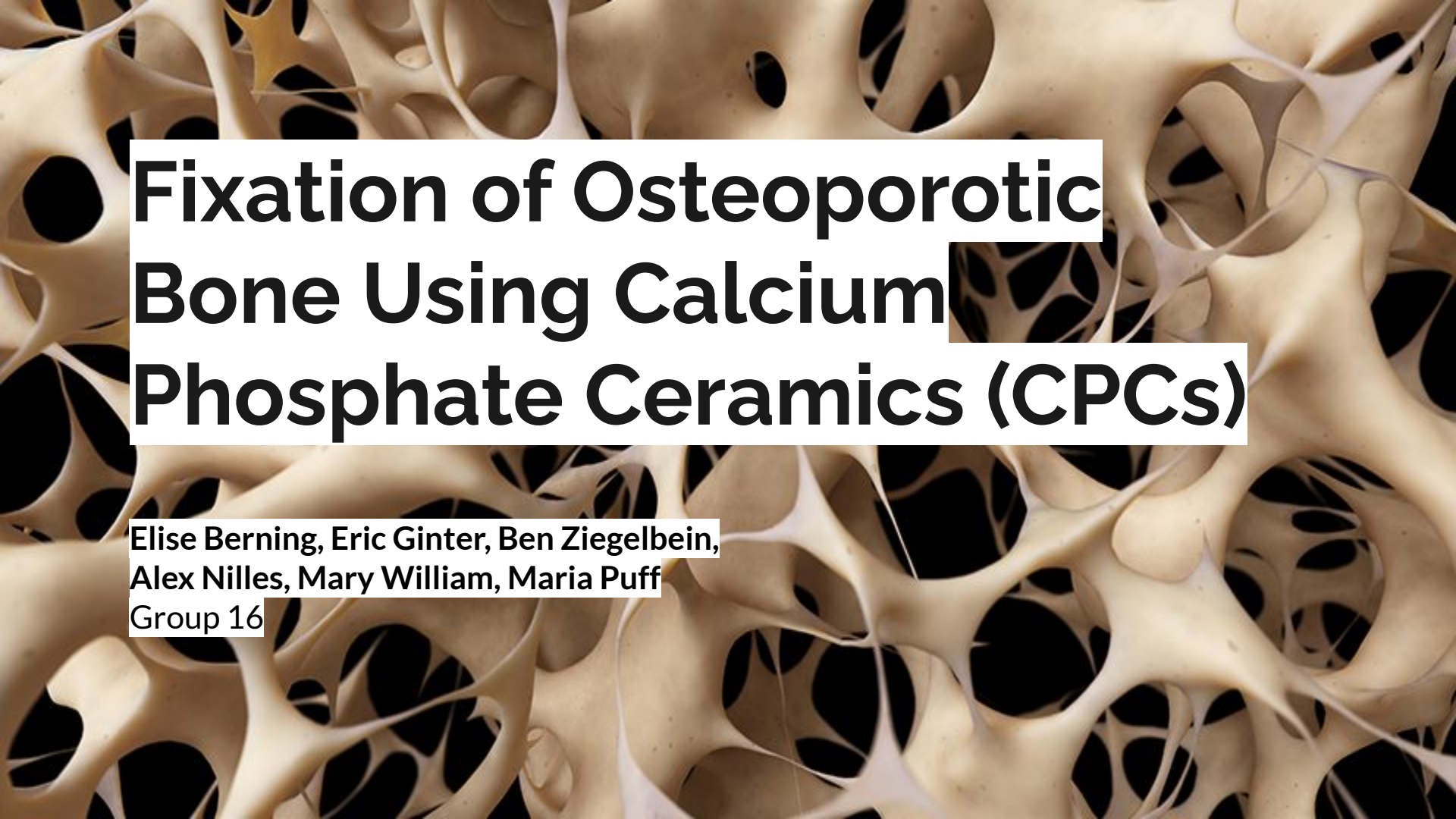

Fixation of Osteoporotic Bone Using Calcium Phosphate Ceramics (CPCs)

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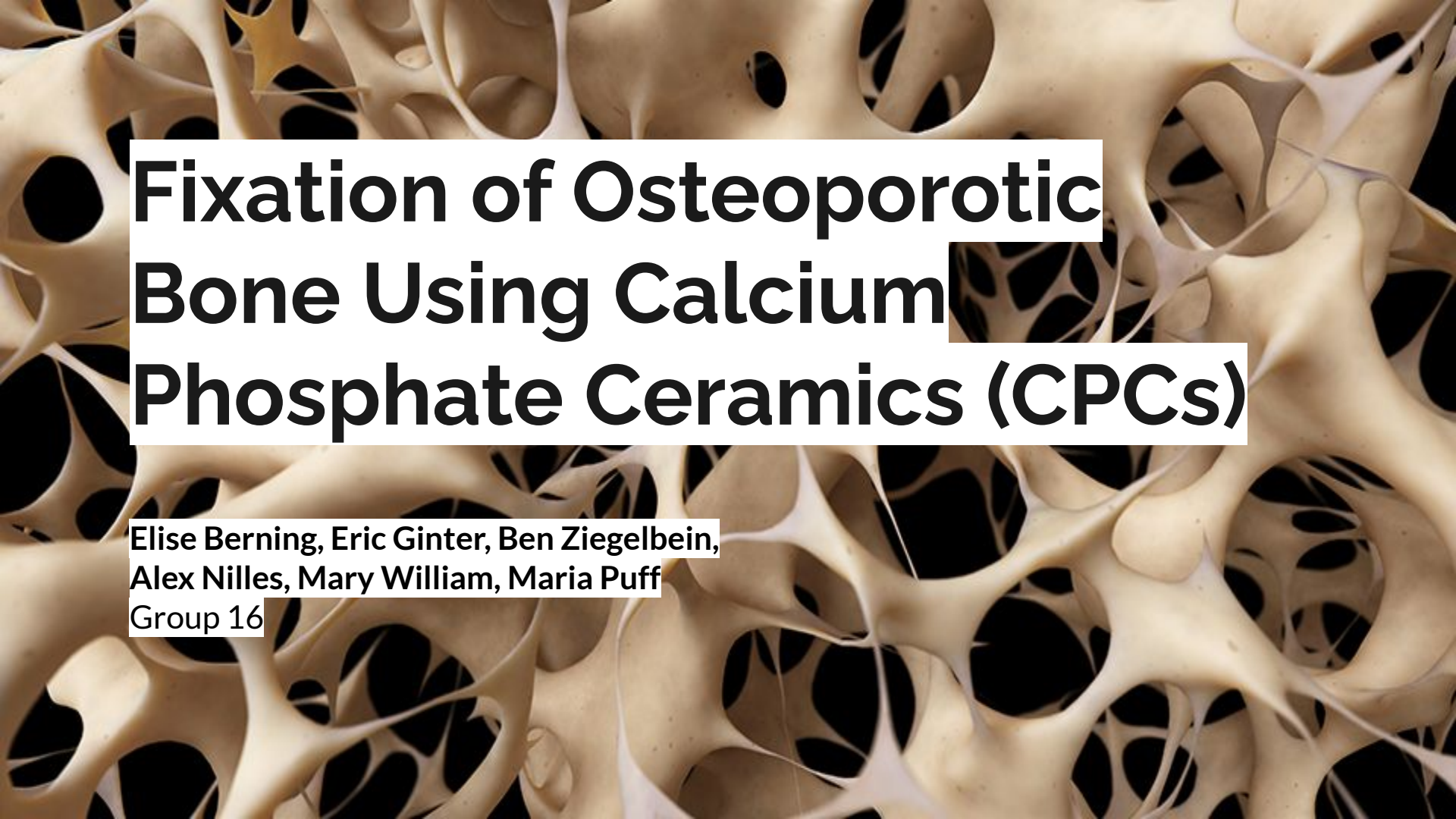
Group 16



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Background

- Osteoporosis and Fragility Fractures
  - According to *Archives of Osteoporosis*, fragility fractures secondary to osteoporosis are highly prevalent, with about 9 million cases yearly worldwide
  - The NHANES estimated 13.9 million people, above the age of 50, to suffer from Osteoporosis in 2020.
- Requirements for Ideal Solution
  - Biodegradability
  - Biocompatibility
  - Mechanical strength

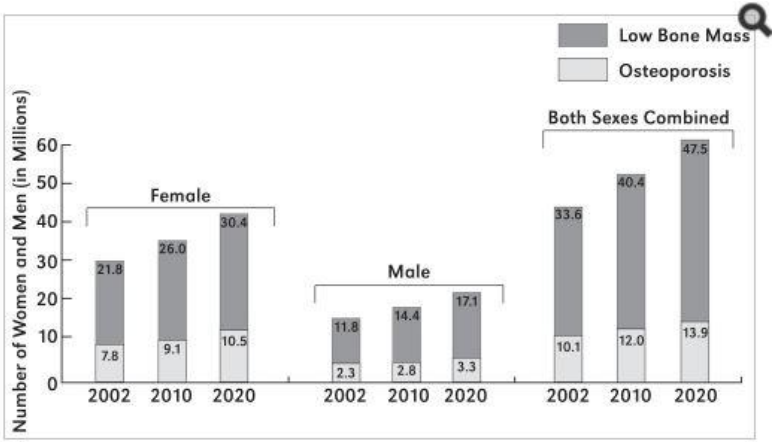
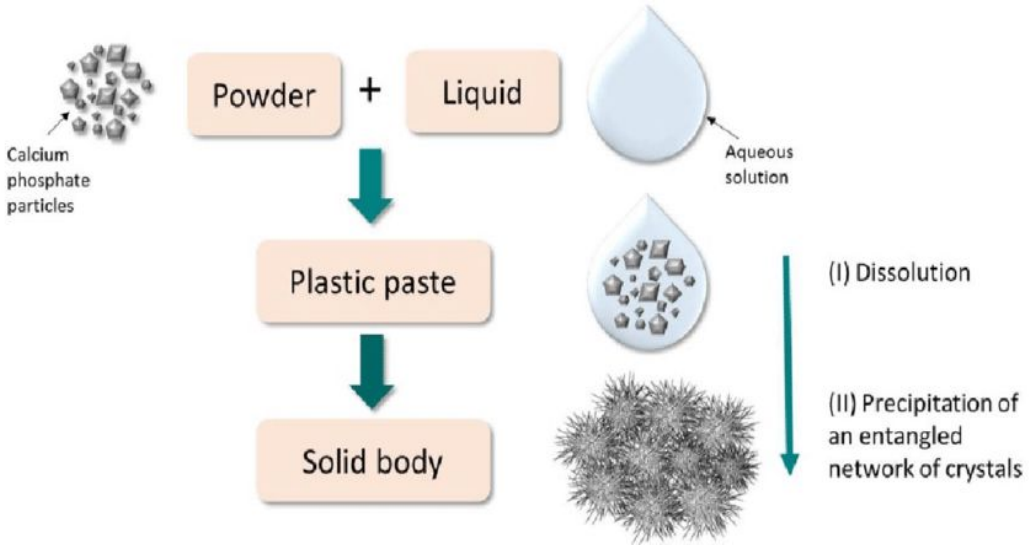


Figure 1: Projected Prevalence of Osteoporosis and/or Low Bone Mass of the Hip in Women, Men, and Both Sexes, 50 Years of Age or Older, *Bone Health and Osteoporosis: A Report of the Surgeon General*.

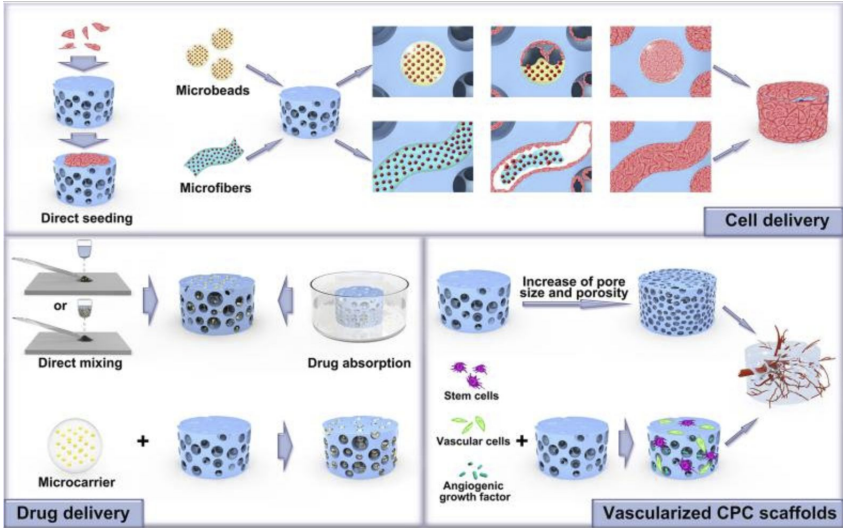
Proposed Solution

- What are calcium phosphate cements?
- Advantages of injectability
- Biocompatibility, bioactivity, biodegradability



Proposed Solution (cont)

- Osteoinductive properties
- Effective scaffold for bone tissue growth
- Versatility
  - Various additives can be introduced to improve certain properties of CPCs
  - Can be used in conjunction with larger fixation implant as potential solution for large fractures

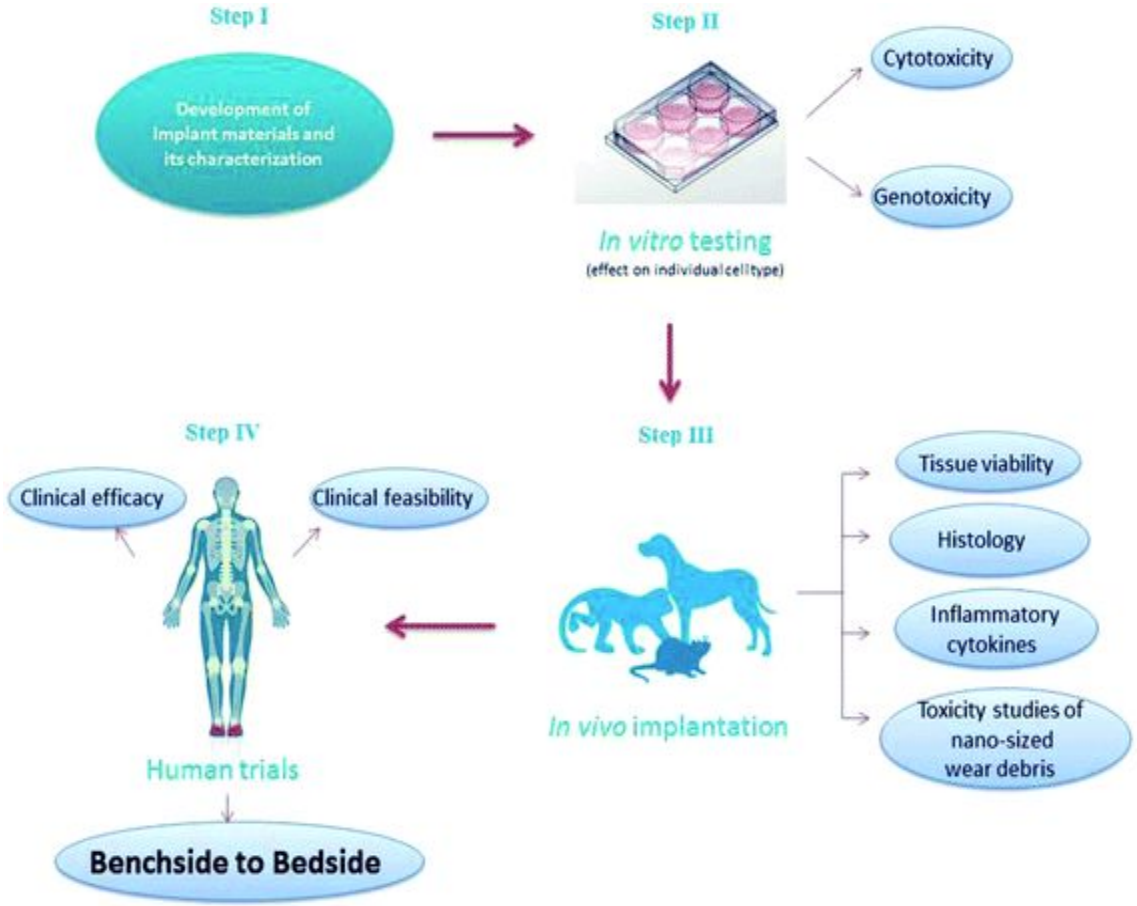


Versatility of CPCs as a bioreactive therapy (*Eliaz, et al.*, 2017).

Models for Testing

After developing the proposed CPC implant, the following stages of testing are required:

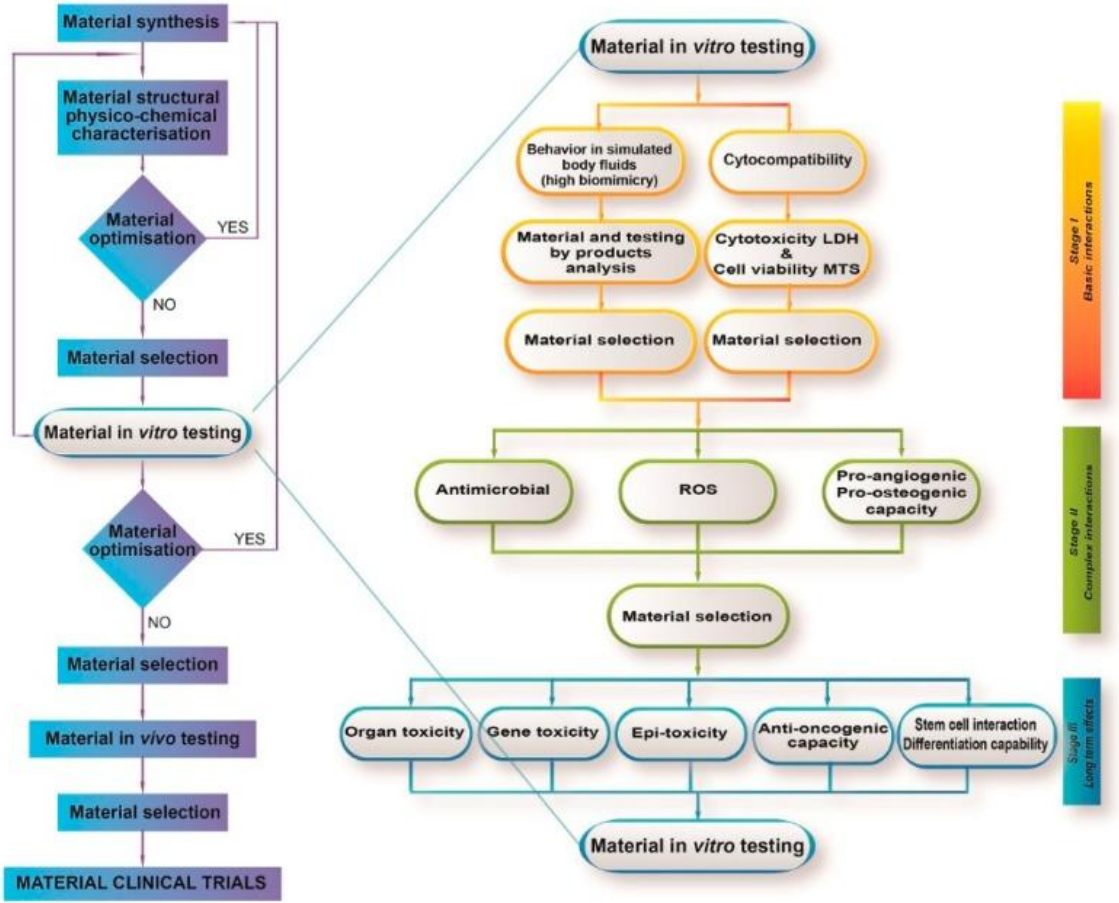
1) <u>In vitro testing</u>
   a) Test multiple cell lines to evaluate CPC's toxicity, debris, oxidative stress, etc on bone osteoblasts (ISO 10993-5:2009)
2) <u>In vivo testing</u>
   a) Use **rat model** to determine CPC effect in dermal implant
   b) Use **canine model** to test CPC in bone implant



Thrivikraman et al, 2011

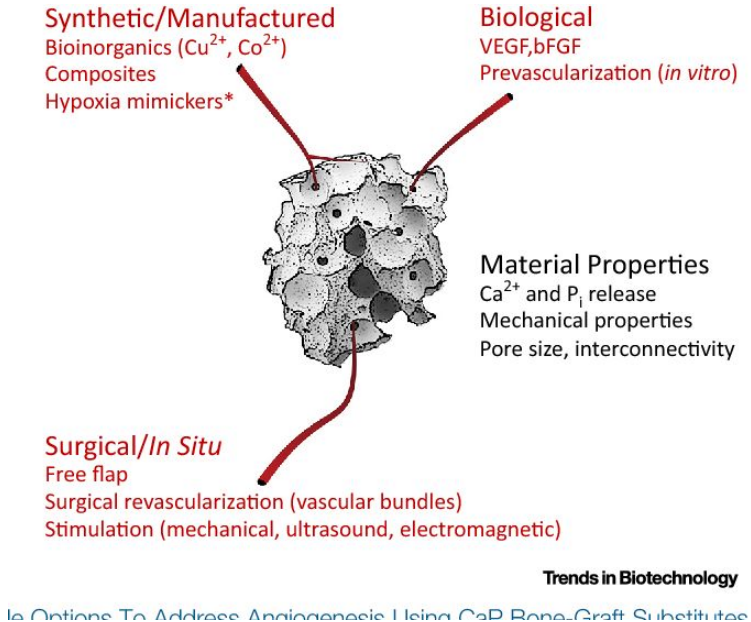
FDA Guidelines

- Developing any biomaterial that adheres to bone is prone to risk
- FDA has rigorous protocols for development and research



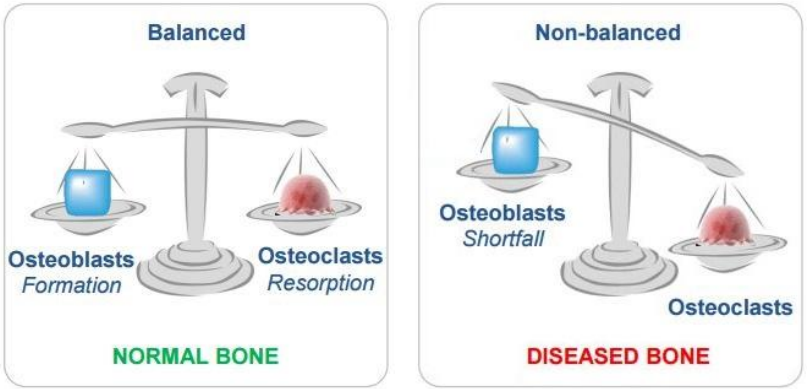
Limitations

- Mechanical properties- CPCs have are brittle, low Young's modulus.
  - Brittle issue because of biomechanics- joints incur more stress than other parts of the body.
  - Mitigate using metal to bear the load
- Pre-vascularization necessary or cells die of hypoxia. Natural angiogenesis isn't fast enough.
  - Can use stem cells, but controversial.
  - Possibly mitigate with some localized drug to speed up angiogenesis?



Future Directions

- Underlying Issue: Excessive bone resorption
  - Osteoclast inhibitor drugs
    - Bisphosphonates
  - Osteogenesis inducing drugs
    - Teriparatide and Denosumab
  - Drug Eluting device ensures proper dosing



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Ginebra, Maria-Pau & Espanol, Montserrat & Maazouz, Yassine & Bergez, Victor & Pastorino, David. (2018). Bioceramics and bone healing. EFORT Open Reviews. 3. 173-183. 10.1302/2058-5241.3.170056.