Microstructure of Hydroxyapatite from Waste Eggshell Synthesized under Different Temperature

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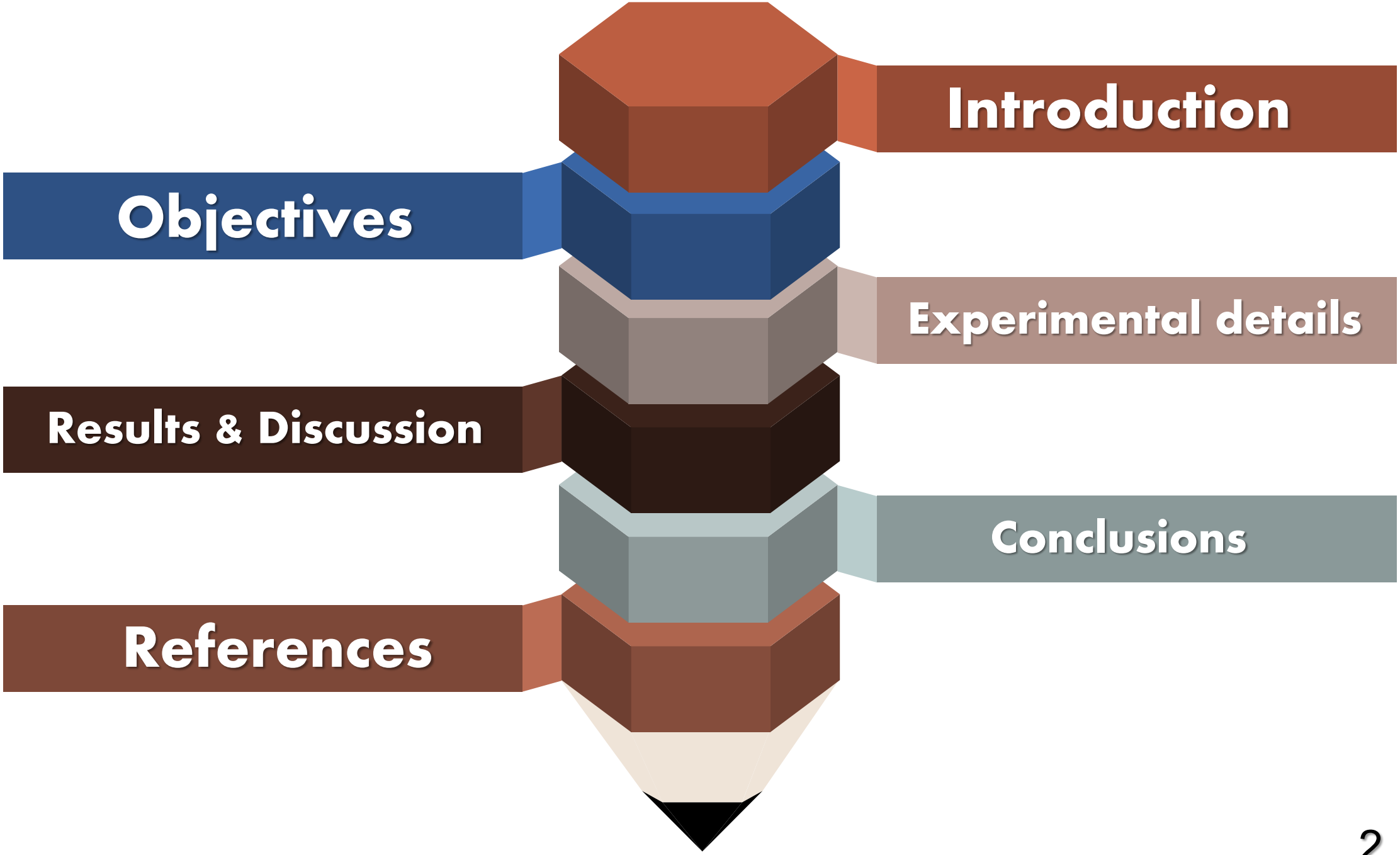
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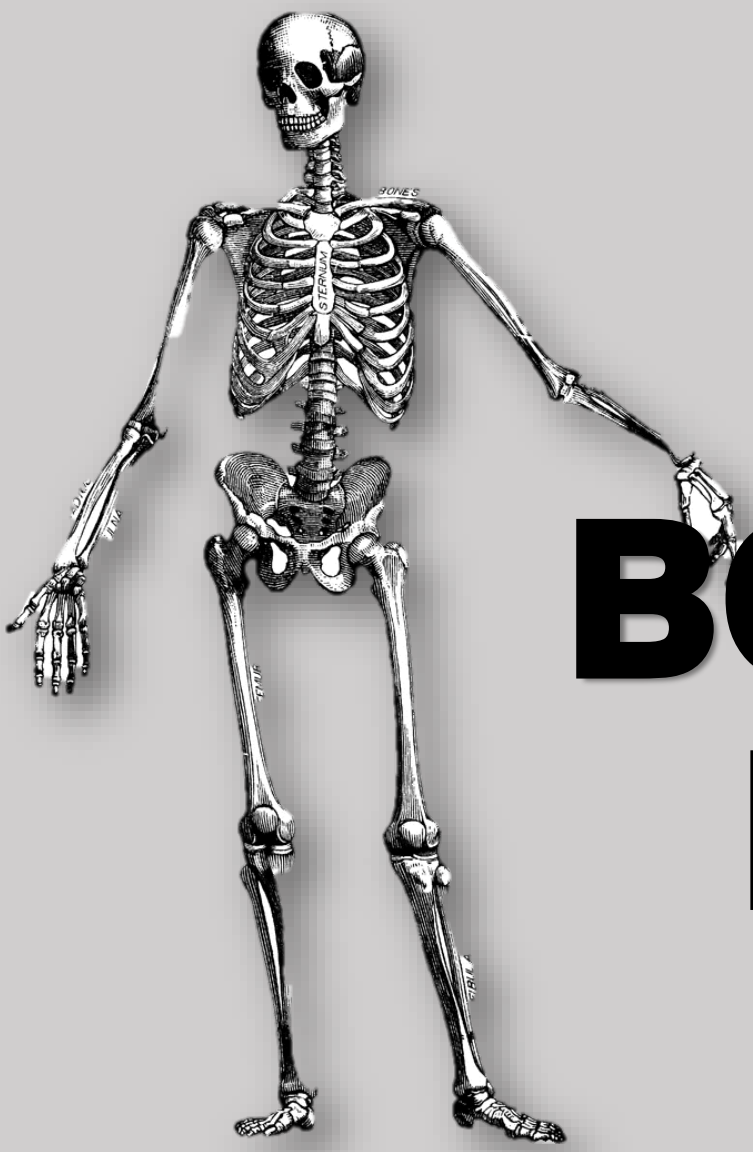
Introduction

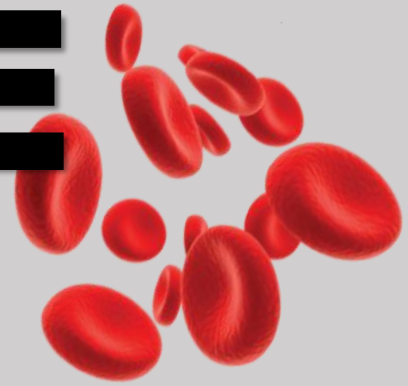


BONE

Support

Protection

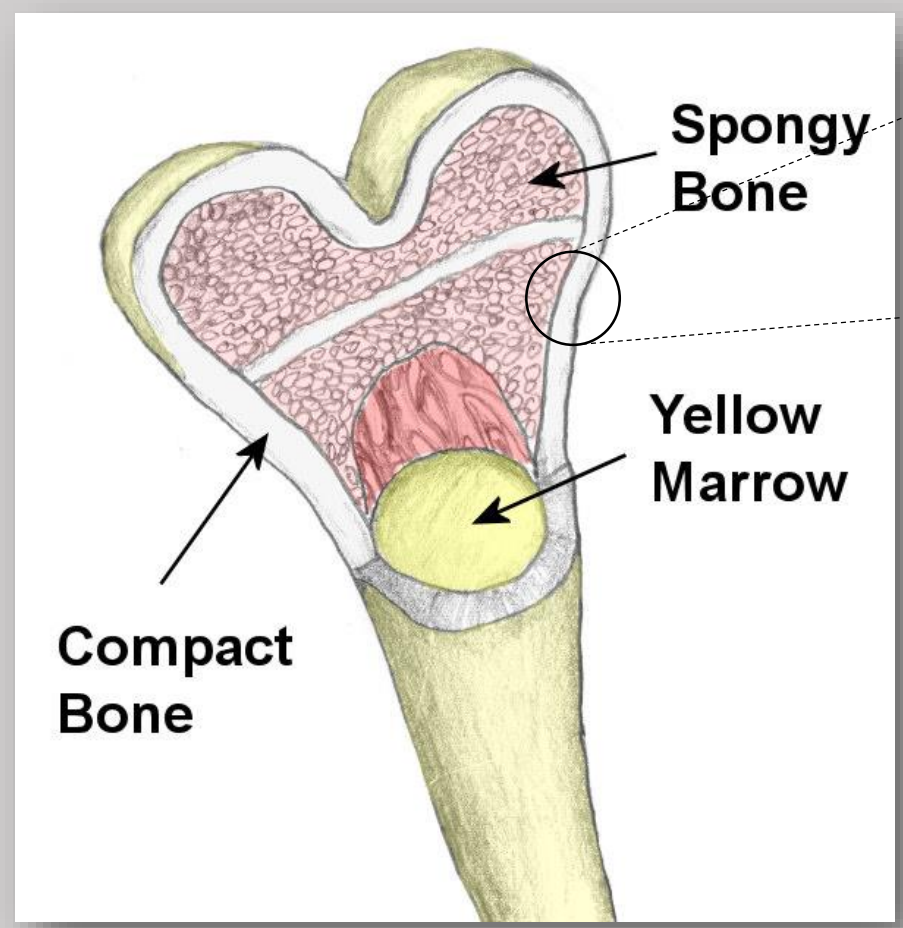
Movement

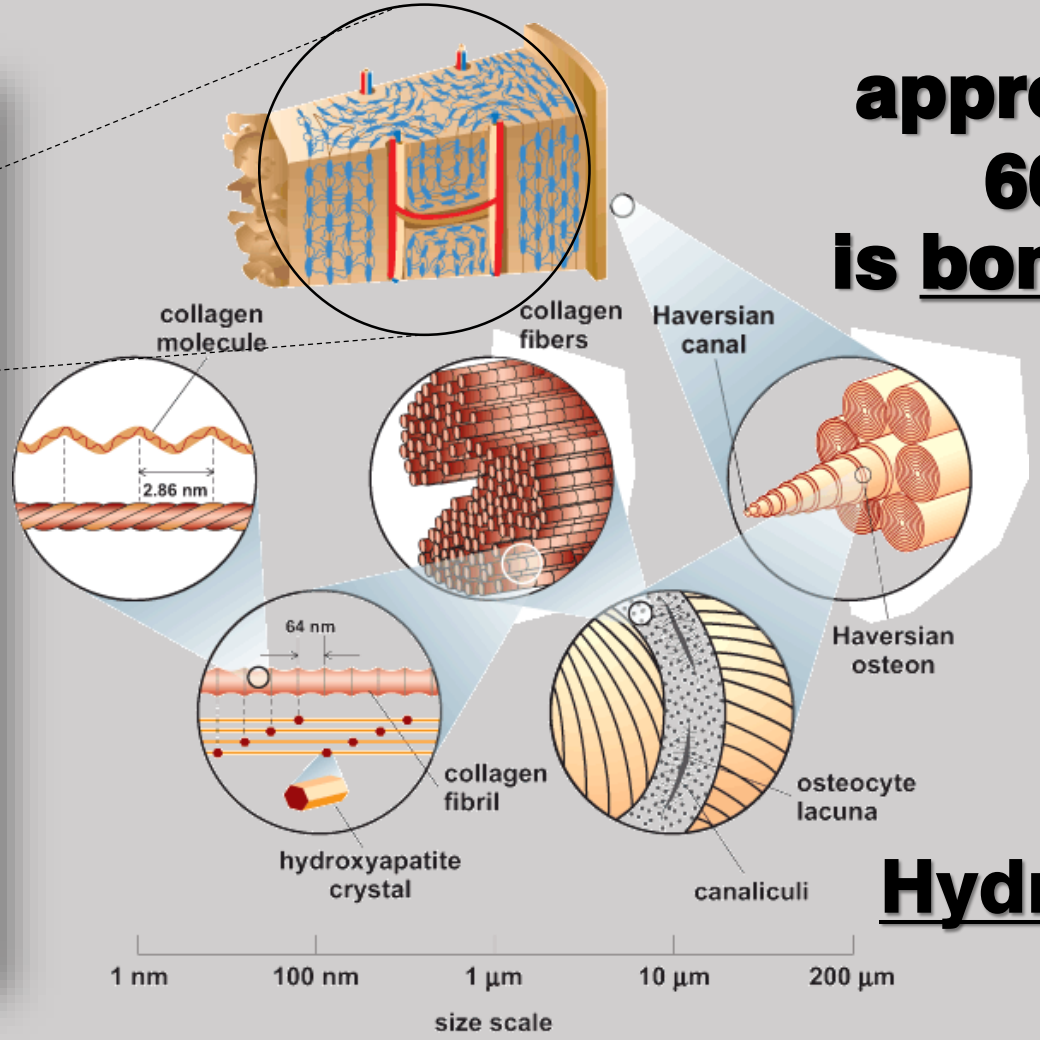


Blood Cell Production

Introduction

Bone structure





approximately 60-70% is <u>bone mineral</u>

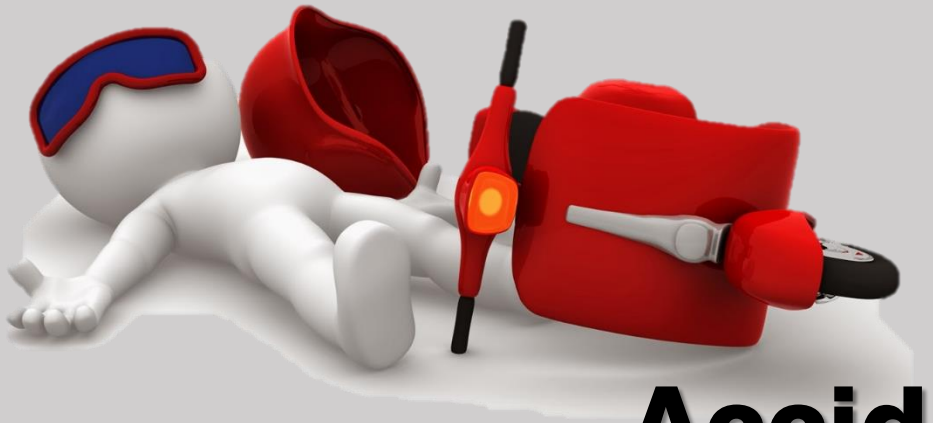
Calcium phosphate

<u>Hydroxyapatite</u>

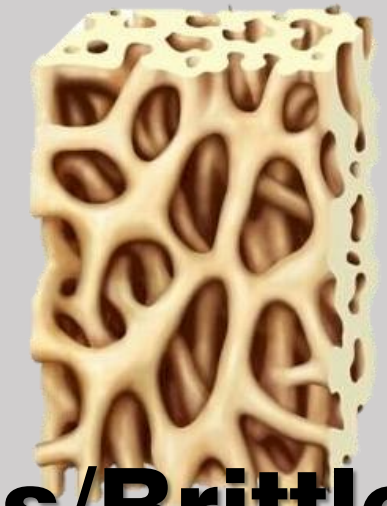
Introduction

Broken bone

loss bone



Accident

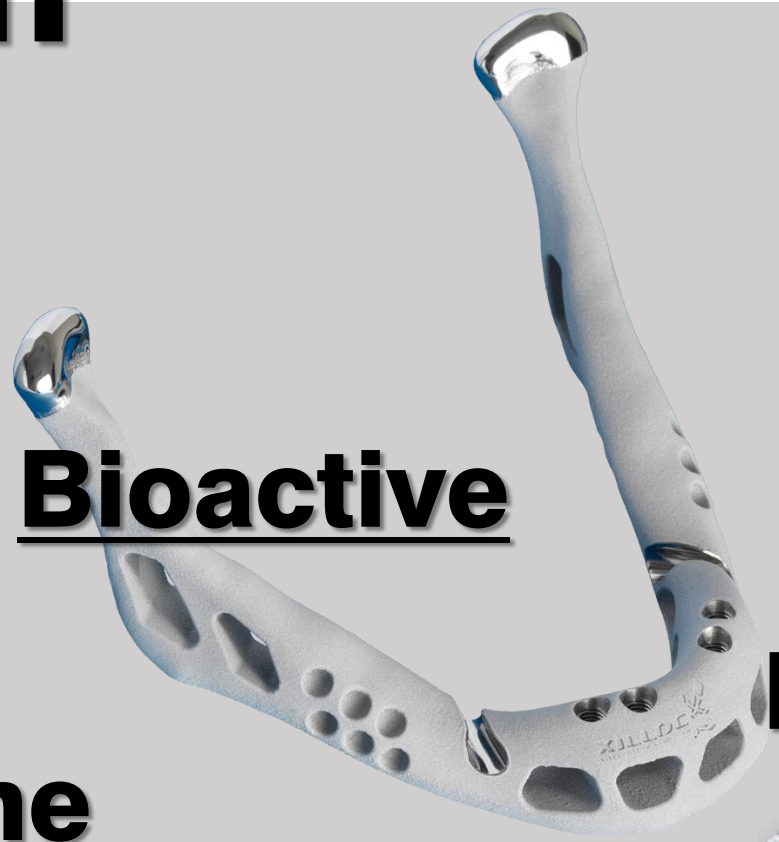


Porous/Brittle bone

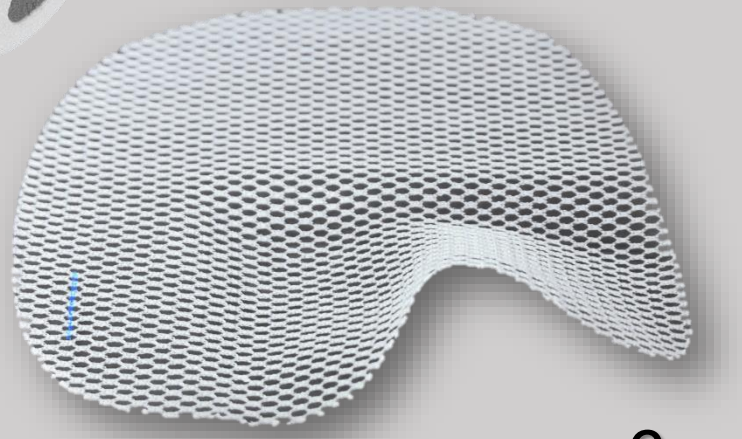
Introduction

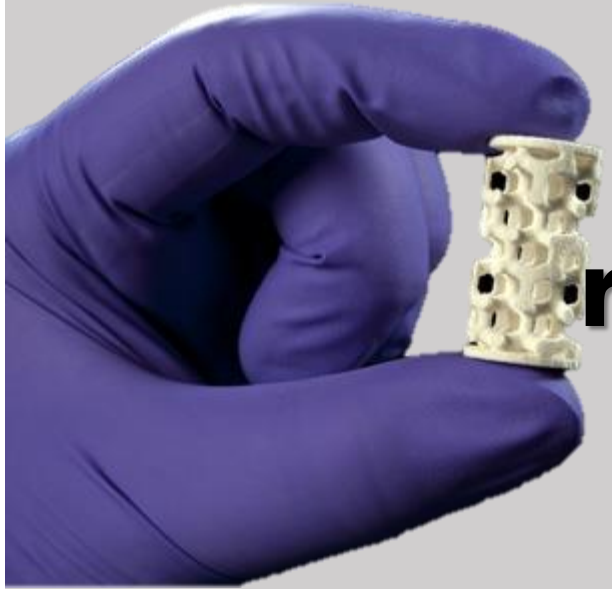
Bioinert

Bioactive



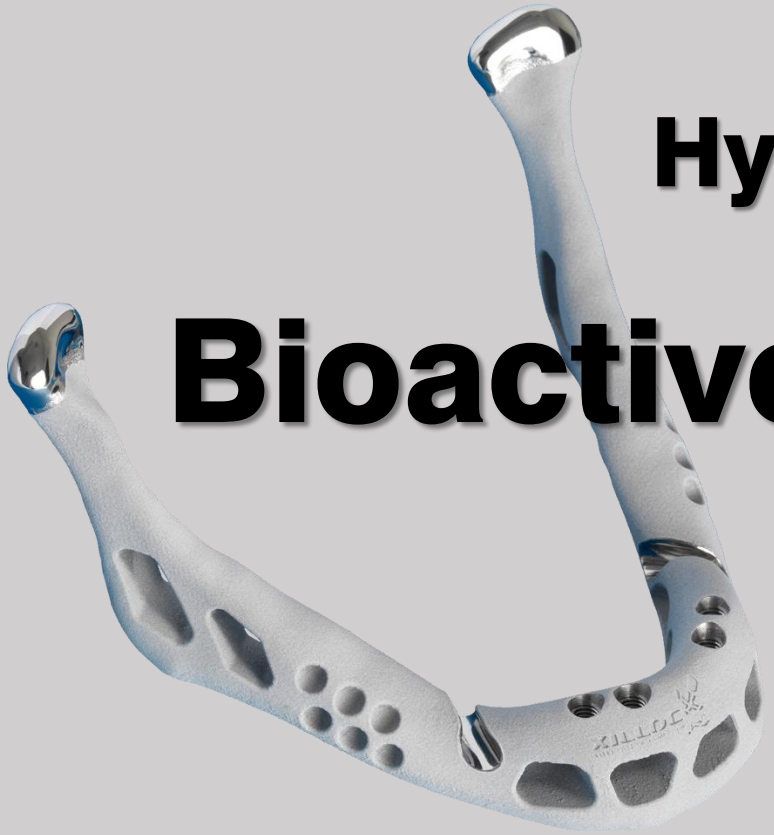
Bioresorbable





Bone replacement material

Introduction



Hydroxyapatite

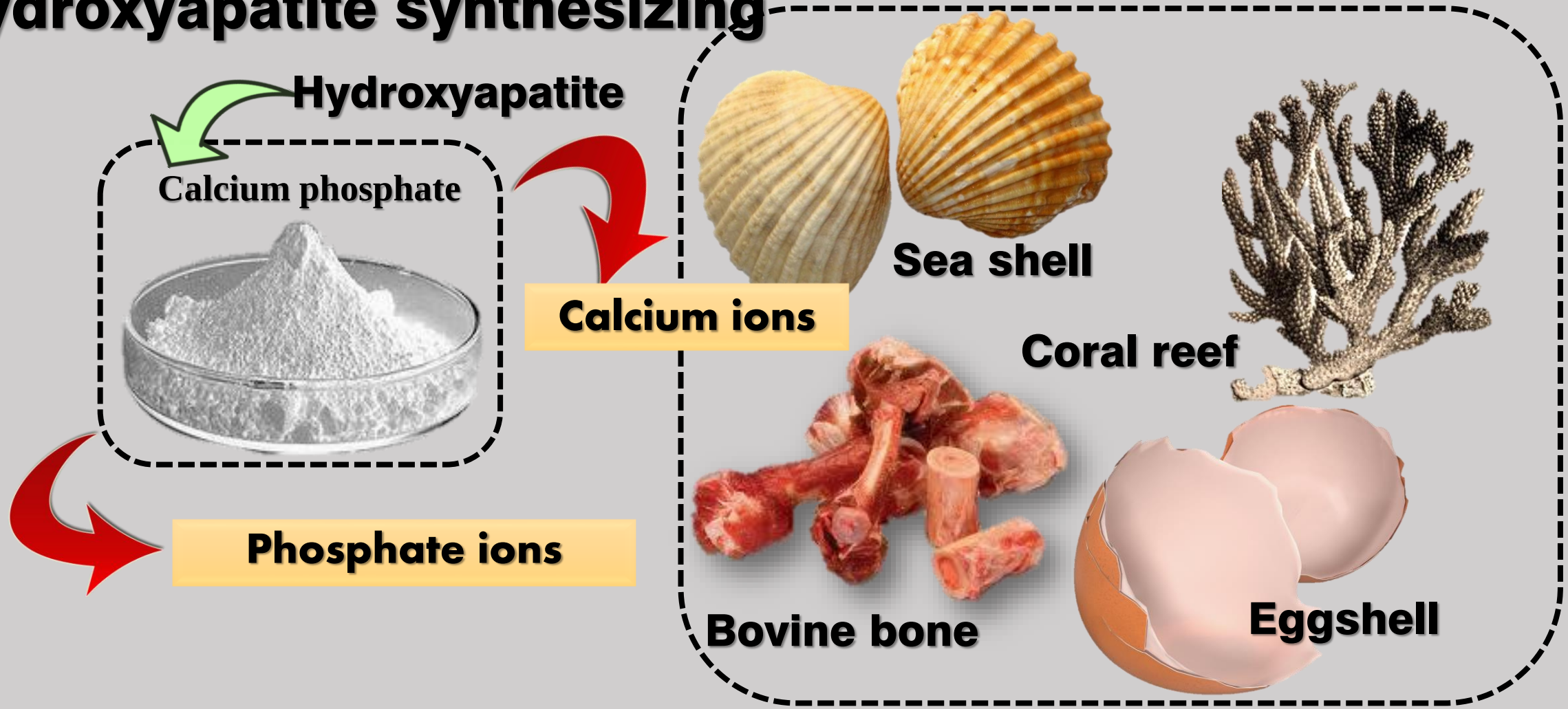
Bioactive

Applications

Human bone contains 60%-70%

Introduction

Hydroxyapatite synthesizing



Introduction

Why the eggshell can be used for synthesizing hydroxyapatite?

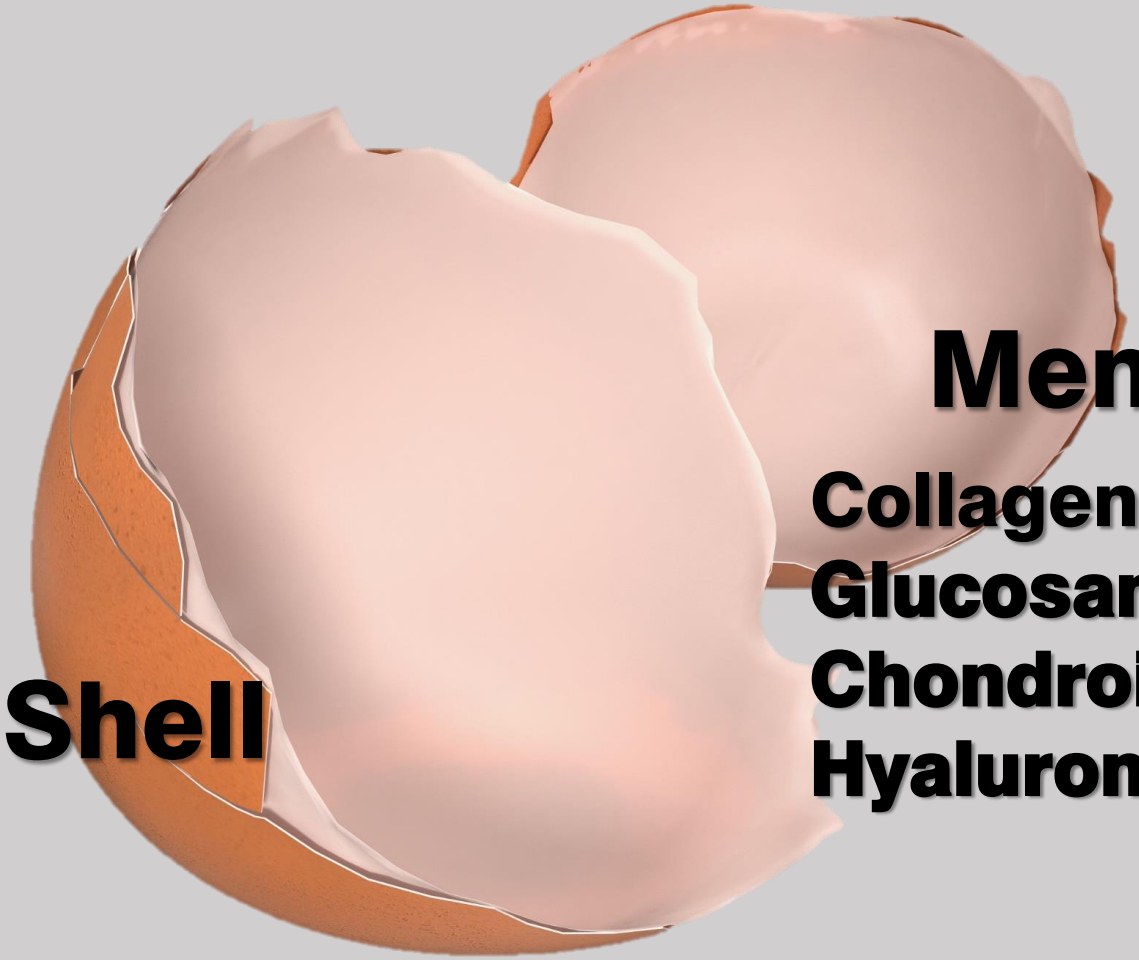
Calcium 95%

$CaCO_3$ 94%

$Ca(PO_4)_2$ 1%

Magnesium 1%

Organic 4%



Membrane

Collagen 35%
Glucosamine 10%
Chondroitin 9%
Hyaluronic acid 5-10%

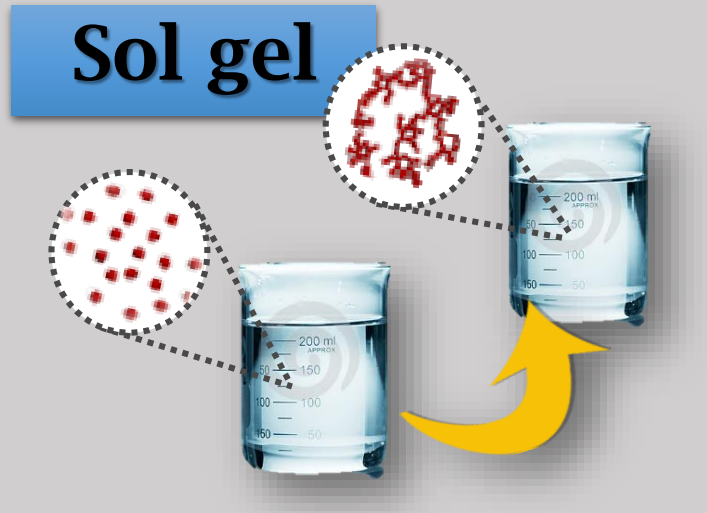
Introduction

Some method to synthesis the hydroxyapatite

Very low cost

Lack of purity

large particle



Small particle
20 – 50 nm

High cost of precursors

Small particle

low cost

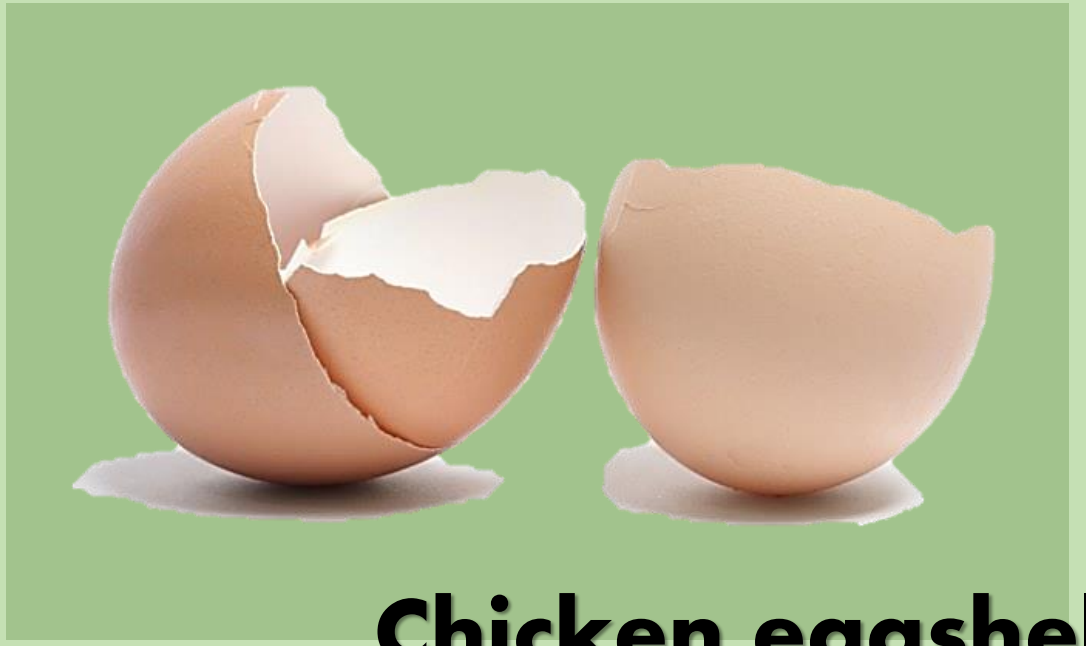
Easy to control

Objectives

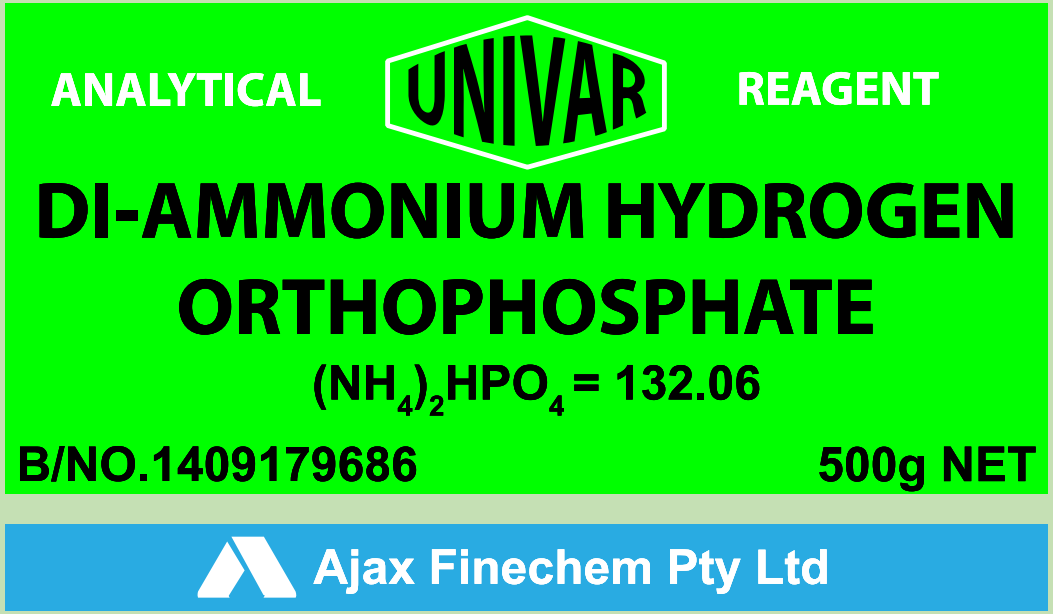
- To synthesis hydroxyapatite from waste eggshells.
- To study the effect of hydroxyapatite synthesizing under different temperature.
- To study the temperature effect on hydroxyapatite from waste eggshell.

Experimental details

Chemical precursors

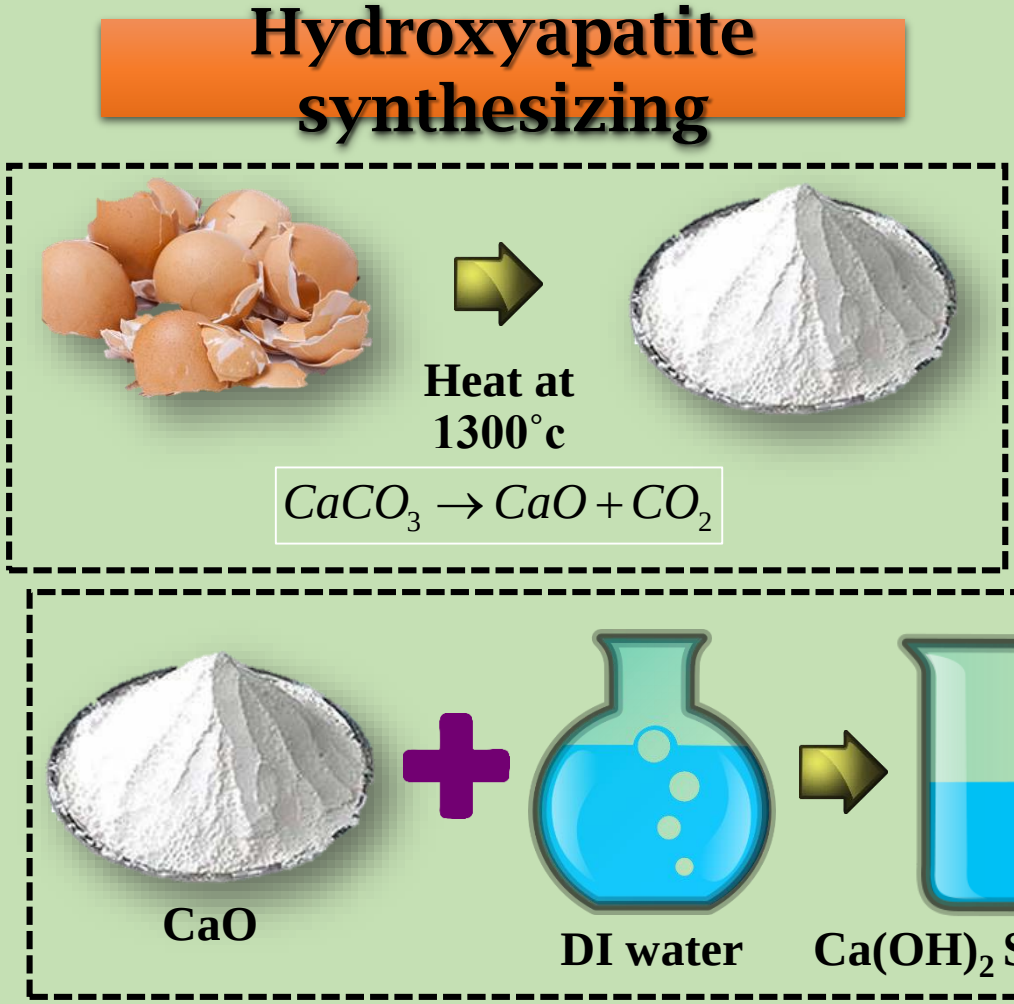


Chicken eggshell



Experimental details

Hydroxyapatite synthesizing



Experimental details

Sample characterization

All of sample

Furnace

Heat at 200-800˚c

XRD

FTIR

FESEM

Results & Discussions

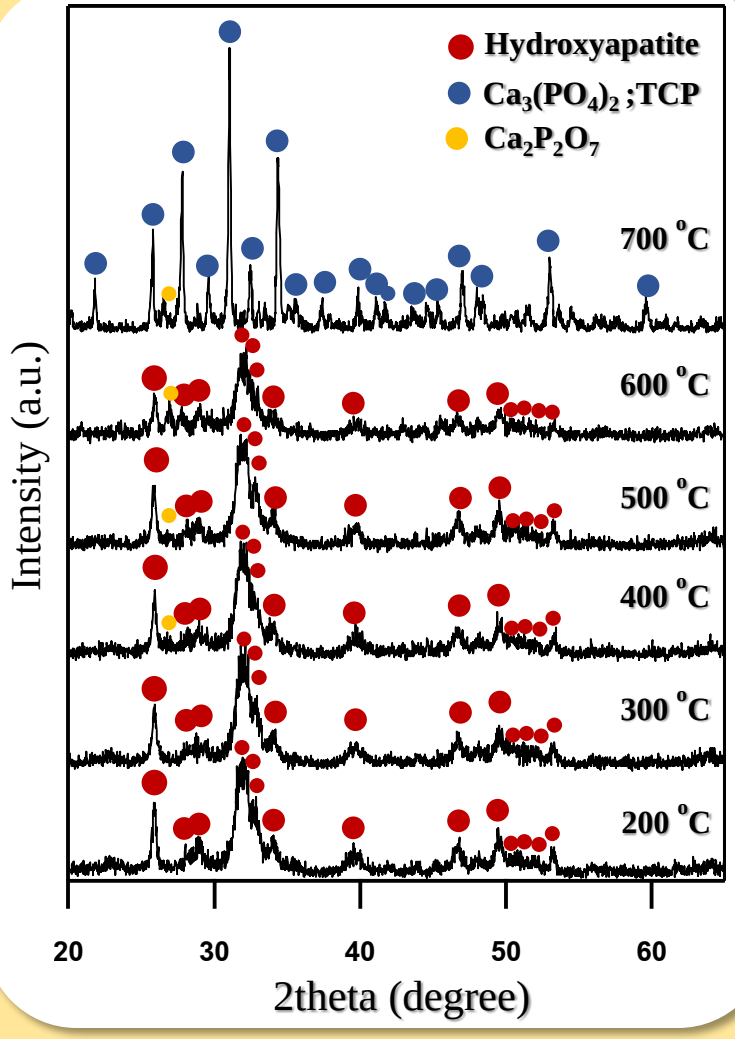


Figure 1. XRD patterns of hydroxyapatite were synthesized at various temperature.

Hydroxyapatite synthesizing

$$10Ca(OH)_2 + 6(NH_4)_2HPO_4 \rightarrow Ca_{10}(PO_4)_6(OH)_2 + 12NH_3 + 18H_2O$$

Hydroxyapatite decomposition

$$Ca_{10}(PO_4)_6(OH)_2 \rightarrow CaO + 3Ca_3(PO_4)_2 + H_2O$$

Wave number (cm^{-1})	Function Group
562 - 1095	(PO_4^{3-})
631	(OH^-)

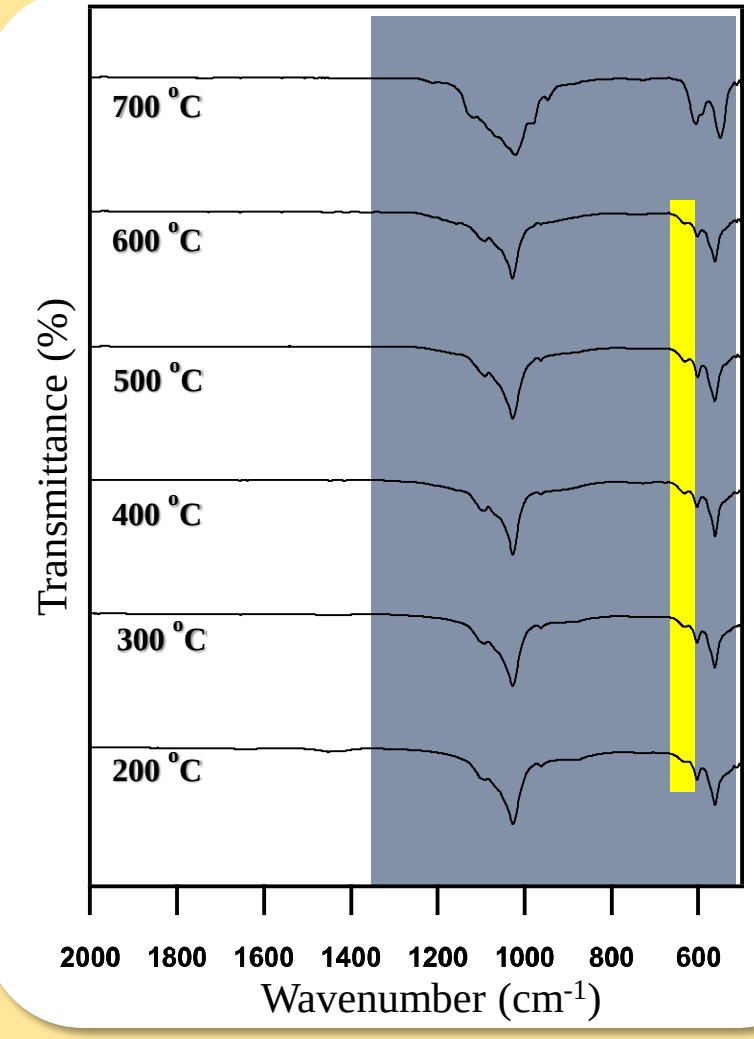
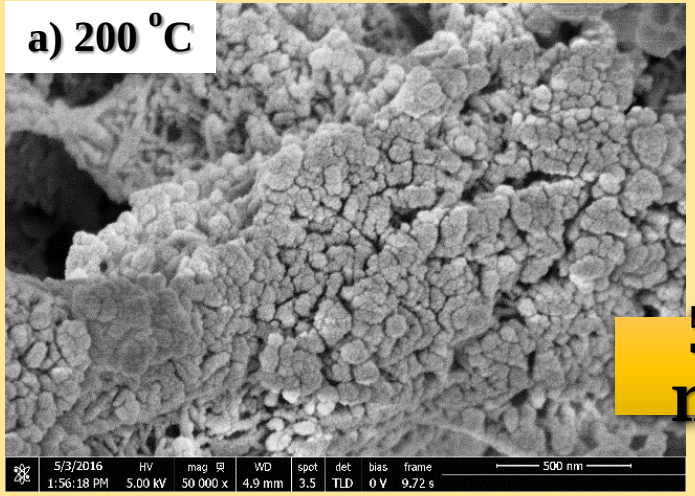


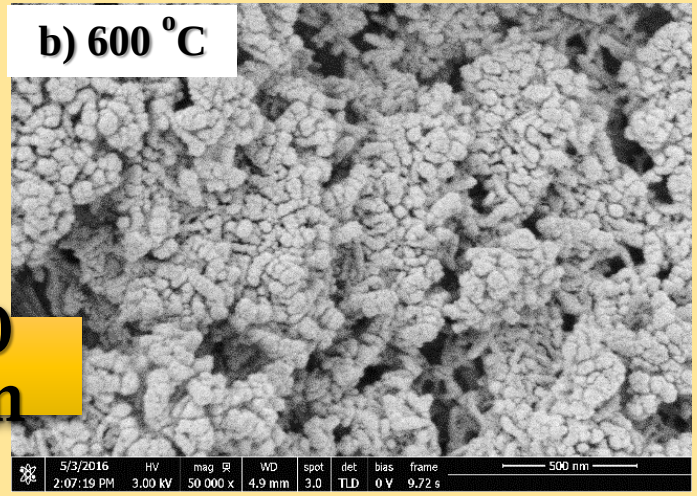
Figure 2. FTIR spectra of hydroxyapatite were synthesized at various temperature.

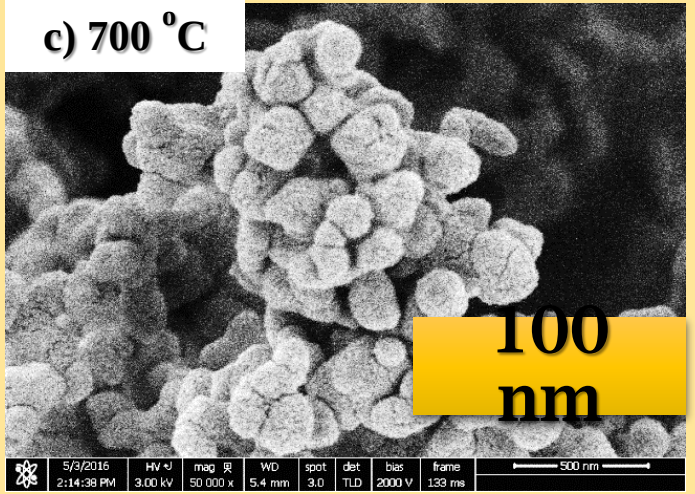
Results & Discussions

FESEM images of hydroxyapatite various synthesizing temperature.



50 nm





100 nm

Figure 3. The FESEM images of sample powder were synthesized at various temperature.

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Results & Discussions

Temperature effect of Hydroxyapatite from chicken egg shell

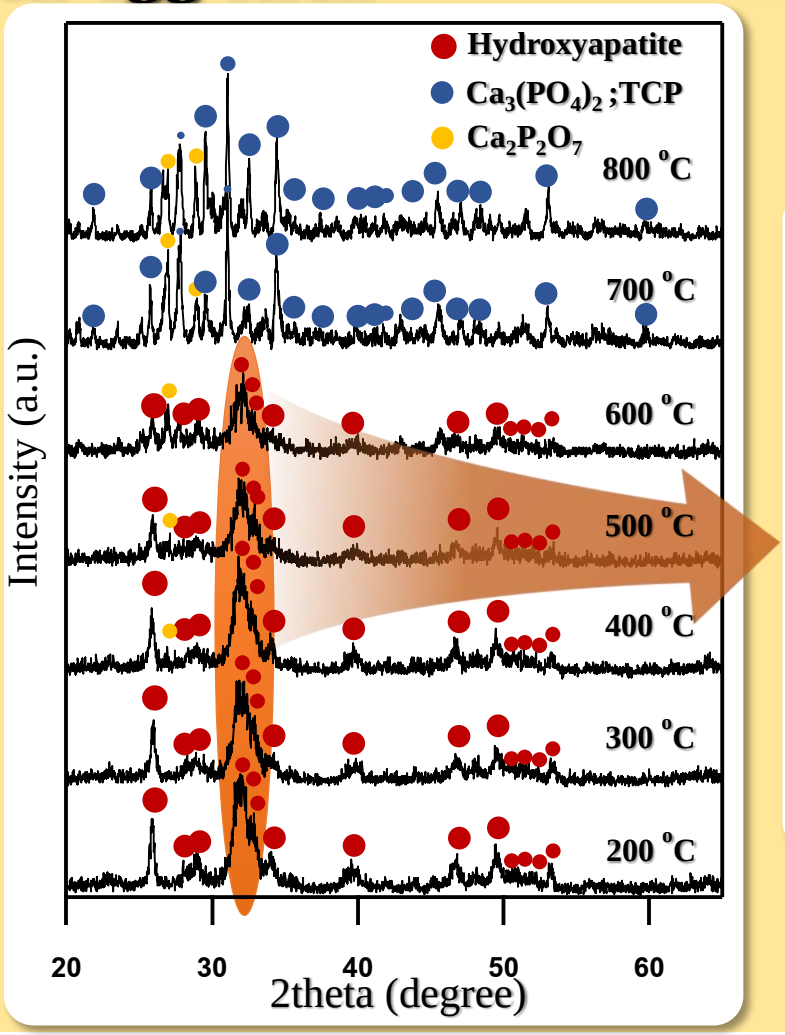

Figure 4. XRD patterns of hydroxyapatite were heated at various temperature.

$$D = \frac{0.9\lambda}{\beta \cos \theta}$$

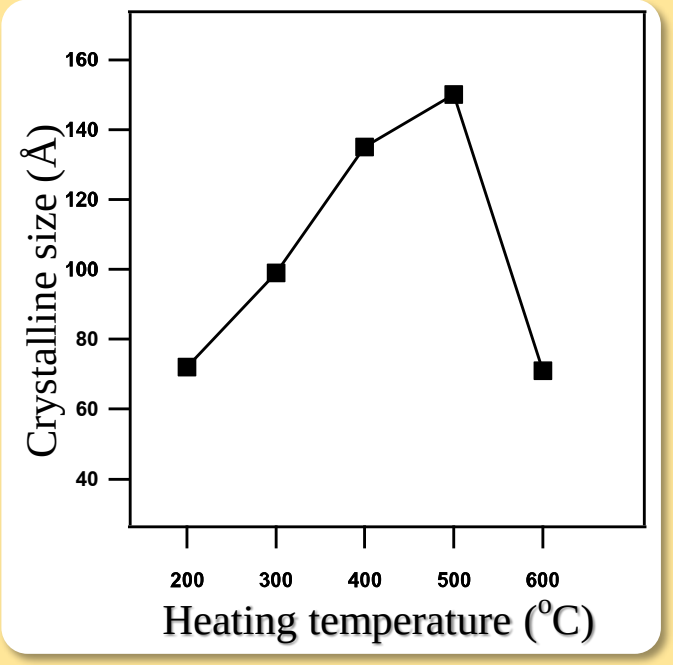

Figure 5. The crystal size of hydroxyapatite were heated at various temperature.

Conclusions

- **Hydroxyapatite can be synthesized from waste eggshells by reaction of $Ca(OH)_2$ and $(NH_4)_2(HPO)_4$**
- **Hydroxyapatite transform to tri-calcium phosphate ($Ca_3(PO_4)_2$) at 700°c of synthesizing temperature.**
- **The particle size of hydroxyapatite synthesized from waste eggshells is around 50 nm.**
- **The crystalline size of hydroxyapatite increase with increasing the heating temperature and hydroxyapatite transform to $Ca_3(PO_4)_2$ after heat over 700°c.**

References

1. Ghazanfari, S.M.H. and Zamanian, A., 2013, "Phase Transformation Microstructural and Mechanical Properties of Hydroxyapatite/Alumina Nanocomposite Scaffolds Produced by Freeze Casting", **Ceramics International**, Vol.39, pp. 9835-9844
2. Bigi, A., Foresti, E., Gandolfi, M., Gazzano, M. and Roveri, N., 1995, "Inhibiting Effect of Zinc on Hydroxyapatite Crystallization", **Journal of Inorganic Biochemistry**, Vol.58, pp. 49-58.
3. Elliott, J.C., Wilson, R.M. and Dowker, S.E.P., 2002, "Apatite Structures", **Advances in X-ray Analysis**, Vol. 1, pp. 172-181**.**
4. LeGeros, R.Z. and LeGeros, J.P., 1993, "Dense Hydroxyapatite", in **An Introduction to Bioceramics**, Hench, L.L. and Wilson, J., 2nd ed., World Scientific, Singapore, pp. 139-180.
5. Seo, H. J., Cho, Y.E., Kim, T., Shin, H.I. and Kwun, I.S., 2010, "Zinc May Increase Bone Formation Through Stimulating Cell Proliferation, Alkaline Phosphatase Activity and Collagen Synthesis in Osteoblastic MC3T3-E1 Cells", **Nutrition Research and Practice**, Vol.4, No.5, pp 356-361.


Thank you!