BMT-73107

Bioceramics and Their Clinical applications

EXAM 09.12.2020

Please answer all your question in WORD or similar and submit your exam's answers in PDF format to jonathan.massera@tuni.fi

Question 1 (5 points):

Bone tissue engineering aims at developing bone substitute able to favour the natural bone healing in a context where, without implant, the bone could not repair itself, i.e. critical bone defects.

Such clinical scenario is routinely encounter, especially in orthopaedics and craniofacial surgery.
a) what are the gold standards when it comes to using bone graft? What are their advantages and disadvantages?

b) What would be the optimum shape for a bone graft and why?

c) Describe one processing technique that could enable you to get such shape and discuss the advantages and disadvantages of such technique

Question 2 (5 points)

Bioactive glasses are surface reactive materials, that are often used in critical bone defect repair.

When considering **silicate bioactive glasses,** explain their dissolution mechanism (If you draw a schematic please explain your figure). What would happen to the bioactivity if the glass crystallizes.

Question 3 (5 points)

Al_2O_3 and ZrO_2 are typically used to produce acetabular head/cup in total hip prosthesis. However, ceramics are rarely used in direct contact with the bone.

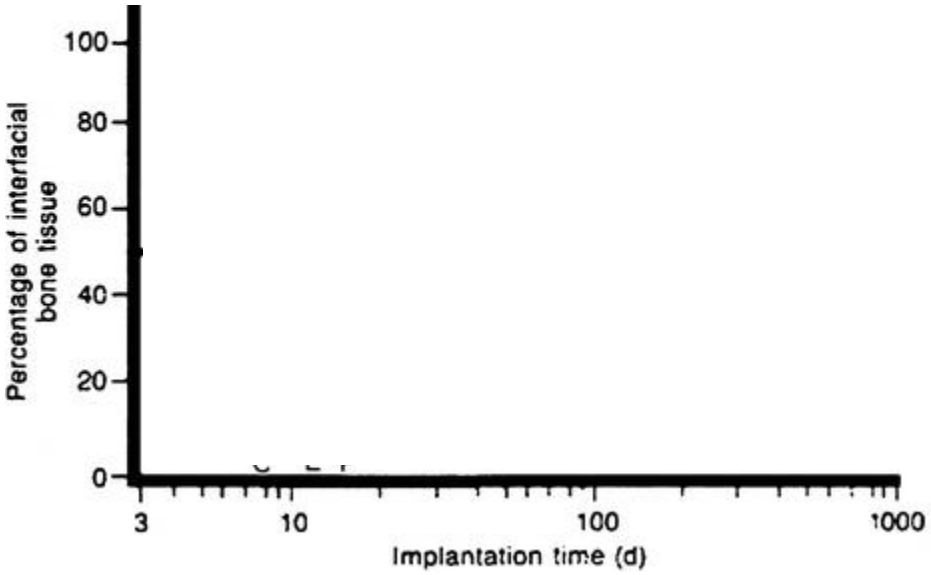
a) Why?
b) Metal stem, in hip prosthesis, do not bind to the surrounding tissue. This can lead to micro-motion that may lead to the implant failure. To resolve the problem ceramic coatings can be applied to the metal stem. What ceramic (give an example) can be used as a coating and what should be the properties of the coating?
c) In dental implant, rather than using Al_2O_3 and ZrO_2, TiO_2 is preferred, why? (the discussion should be in regard to the tissue/material interaction)

Question 4 (5 points)

Please explain what the index of bioactivity is.

What does it mean, for a material, to be bioactive class A or Class B?

Using a graph where you will have “percentage of interfacial bone tissue” in the y-axis and “implantation time” in the x-axis see figure below, represent the line (if applicable) corresponding to 1) a bioresorbable, 2) bioactive class A, 3) Porous coating, 4) nearly inert materials



Question 5 (5 points)

Researcher are focusing their effort to develop composites and hybrid biomaterials.

a) What is the rational for focusing on such type of materials?
b) What is the difference between hybrid and composites biomaterials?

Question 6 (5 points)

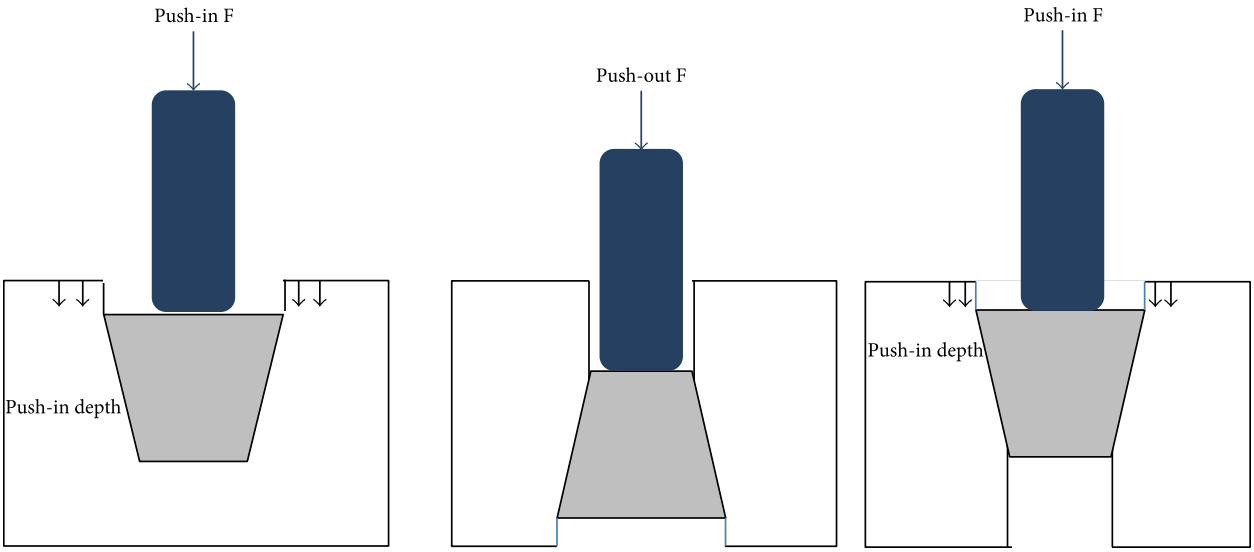
When studying new biomaterials, the first step is to evaluate the in-vitro dissolution using Simulated Body Fluid.

What is Simulated Body Fluid? And why is it to use in the evaluation of bioactive materials?

Then comes the in-vitro cello culture:

Describe the three main techniques that can be used to evaluate the cell interaction with a material.

Question 7 (5 points)



Above are presented three different (standardized) method to conduct a push-out/push-in test.

Why do we perform such test? i.e. what information will we get from a push-out/push-in test?

If you implant three materials (Pure titanium, Titanium treated with NaOH, bioactive glass) how will the push-out/push-in value change and why?

Question 8 (5 points)

In clinics hydroxyapatite (HA) and tricalcium phosphate (TCP) are the most used synthetic biomaterials when bone regeneration is targeted.

What is the difference in tissue/material interaction between these two materials?

If HA is similar to the mineral part of the bone, why does it degrade faster than bone?

TCP is often used as part of a cement (bone cement) what are the challenges when developing a bone cement?