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STEM CELLS IN DENTISTRY

DENTAL CLINIC

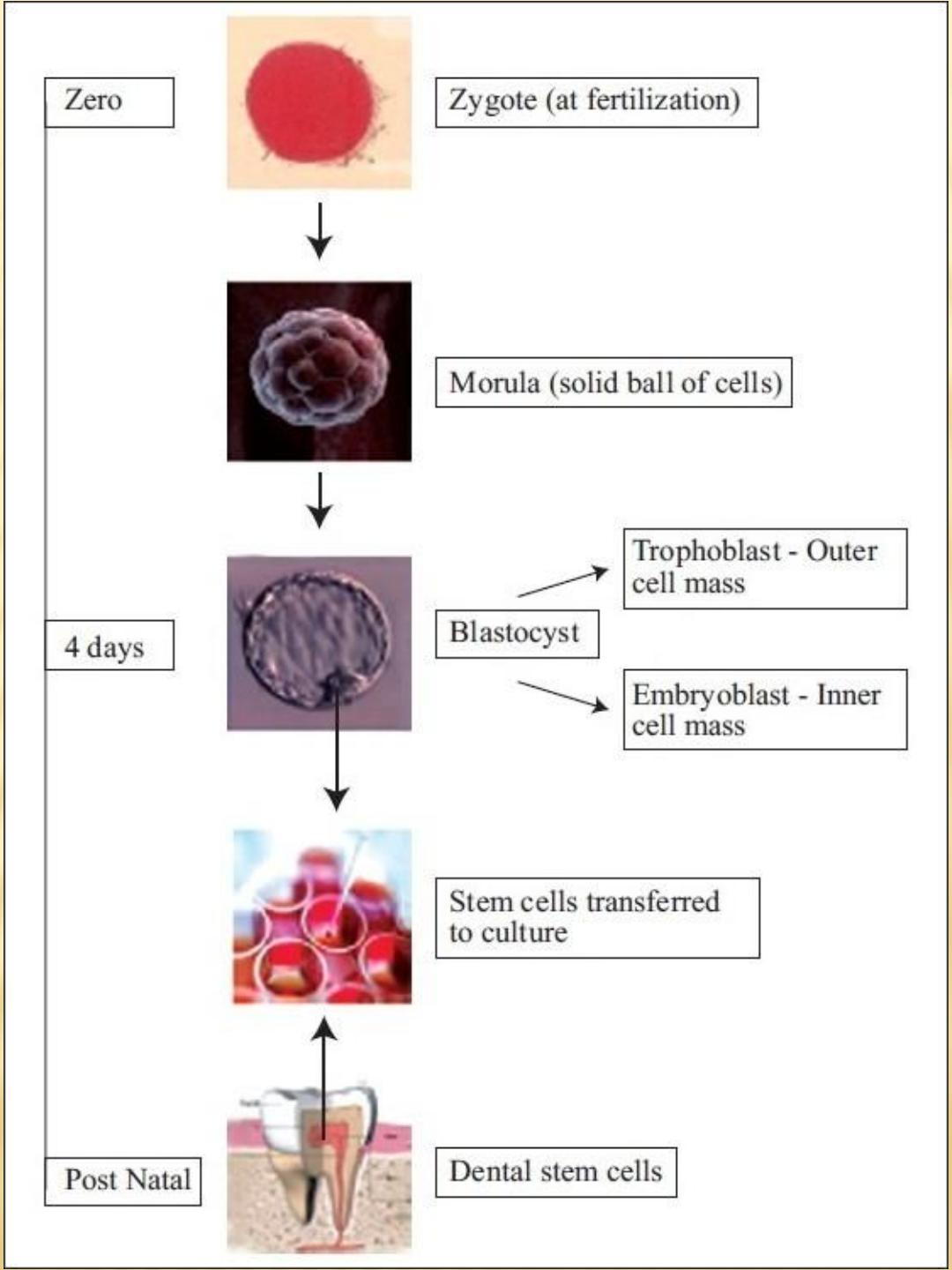
21st Century Dental Clinic

STEM CELLS

- Undifferentiated cells with ability to divide and give rise to identical cells
- Under specific condition they can differentiate to various cell types

POTENCY OF STEM CELLS

- Totipotent – the aibility to differentiate into other types of cells (fertilised egg)
- Pluripotent – into almost all cell types (inner cell mass in blastocyst)- all tissues
- Multipotent – into a closely related family of cells (ectoderm,mesoderm,entoderm)
- Unipotent – cells of their own type only, but have the property of selfrenewal


Zero
Zygote (at fertilization)
Morula (solid ball of cells)
4 days
Trophoblast - Outer cell mass
Blastocyst
Embryoblast - Inner cell mass
Stem cells transferred to culture
Post Natal
Dental stem cells

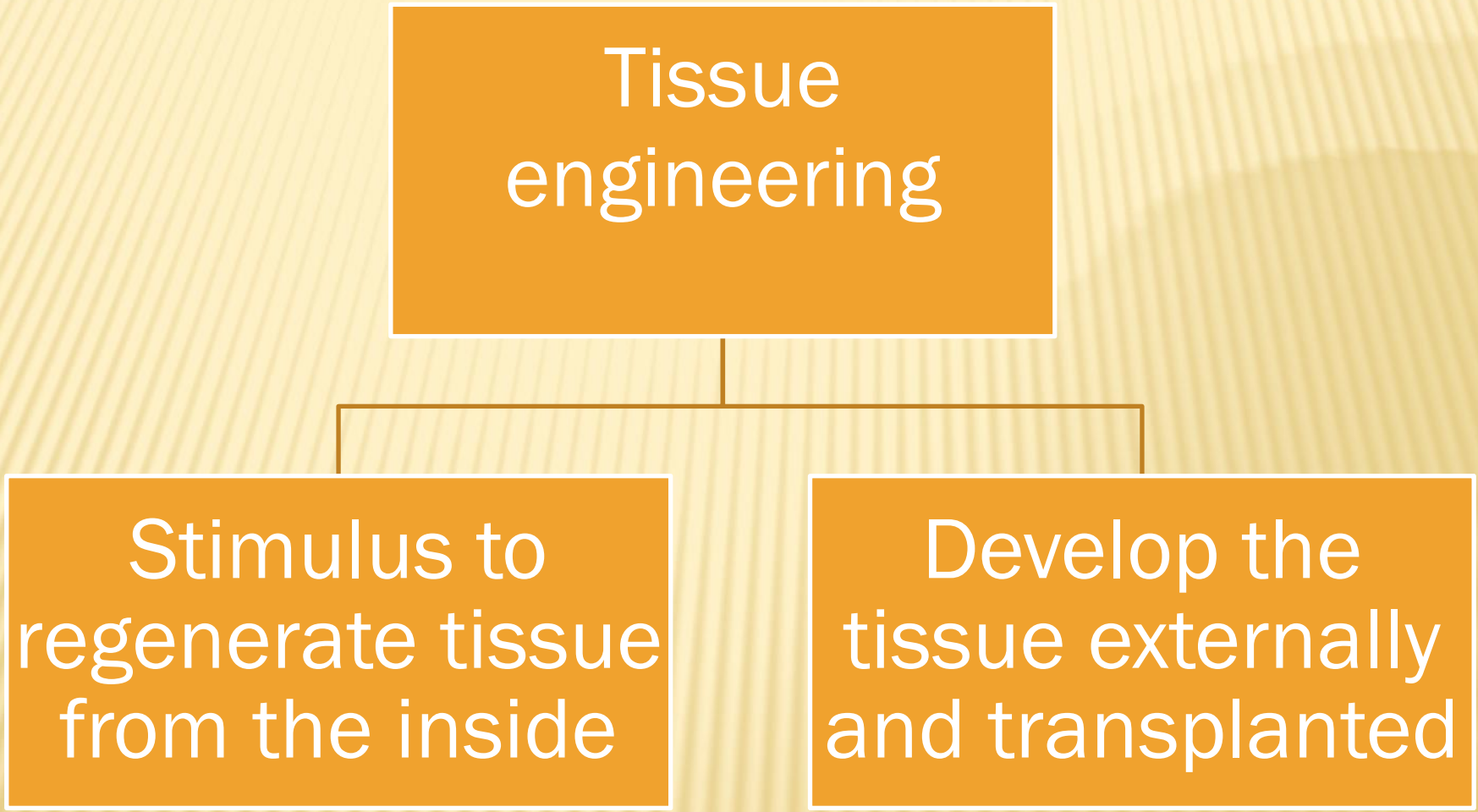
STEM CELLS

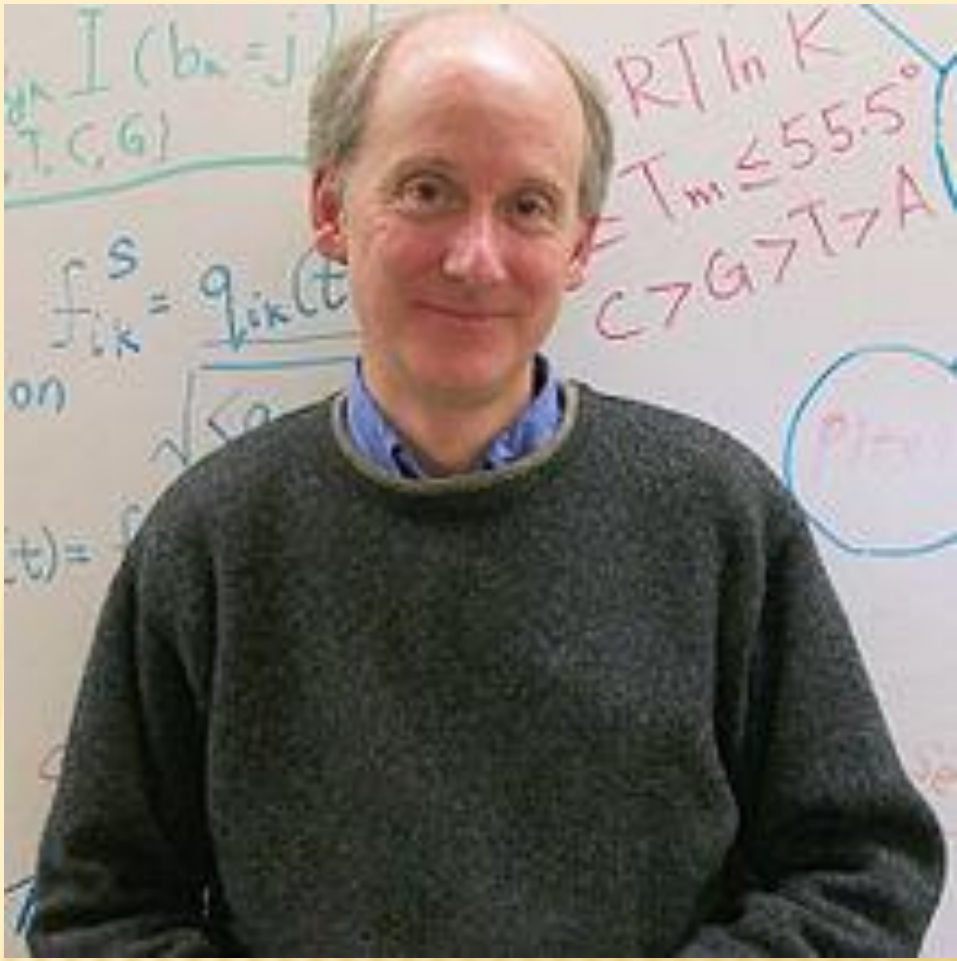
embryonic

- Embryoblast
- Umbilical cord blood

adult

- Bone marrow
- Skin
- Adipose tissue
- Dental pulp


Tissue engineering
Stimulus to regenerate tissue from the inside
Develop the tissue externally and transplanted



J.A. THOMSON , 20.12.1958

"Embryonic Stem Cell Lines Derived from Human Blastocysts", *Science*, November 6, 1998.

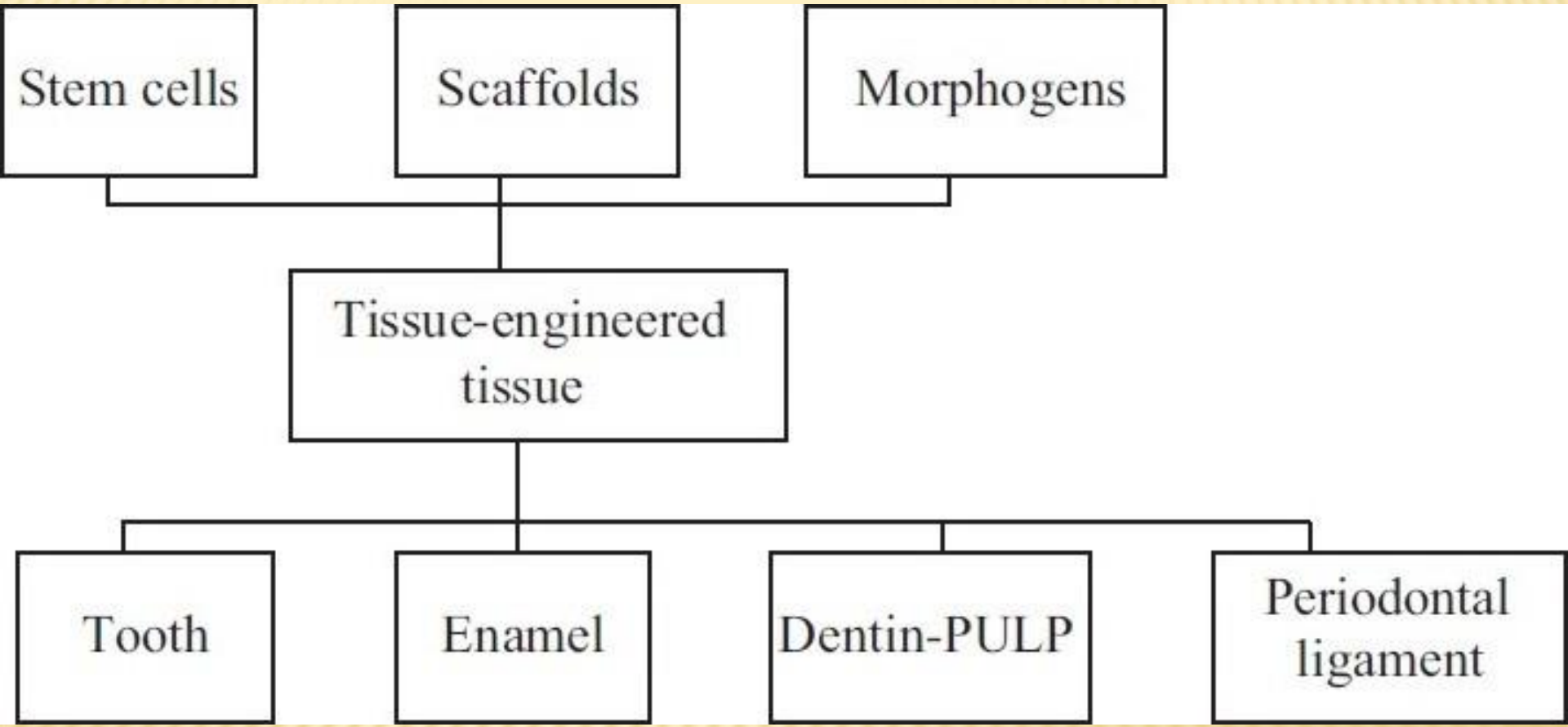
	Embryonic	Adult
Source	Embryo	Adult tissue
Potency	Pluripotent	Limited differentiation
Cell culture	Easy	Challenging
Chances of rejection after transplantation	Yet to know	Less likely
Obstacle for usage	Ethically controversy	Need patient consent

THE TOOTH – A TREASURE CHEST OF STEM CELLS

Volponi AA, Sharpe PT, Br Dent J, 2013

Restoring damaged dental tissues :

1. Vital pulp engineering
2. Regeneration of periodontal ligament lost in periodontal disease
3. Generation of complete or partial tooth structures to form biological implants


Stem cells
Scaffolds
Morphogens
Tissue-engineered tissue
Tooth
Enamel
Dentin-PULP
Periodontal ligament

THE TOOTH – A TREASURE CHEST OF STEM CELLS

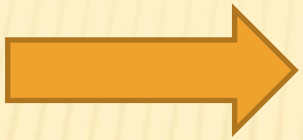
Mesenchymal stem cells terapies

- Bone and muscle regeneration
- Treating immunodisorders (e.g.lupus erythematosus)

Epithelial cells from gingiva

- Ocular surface disorders

Success of osseointegrated implants from biocompatible materials depends on many parameters



stem cells

tissue engineering

Dental epithelial stem cells

- Are lost after eruption

Dental mesenchymal stem cells

DENTAL MESENCHYMAL STEM CELLS

- Fibroblast like morphology
- Aibility to adhere on plastic tissue-culture surfaces
- Osteogenic potency

DENTAL MESENCHYMAL STEM CELLS

- Dental pulp stem cells(DPSC)
- Stems cells from human exfoliated deciduous teeth(SHED)
- Periodontal ligament stem cells(PDLSC)
- Dental folicle stem cells(DFSC)
- Stem cells from the dental apical papilla(SCAP)

THE EFFICACY OF MESENCHYMAL STEM CELLS TO REGENERATE AND REPAIR DENTAL STRUCTURES

Shi et al , Orthod Craniofac Res , 2005

Impacted third molars

Dental pulp stem cells (DPSC)

Stem cells from human exfoliated deciduous teeth (SHED)

Periodontal ligament stem cells(PDLSC)

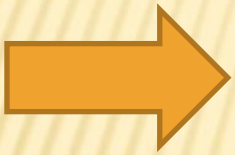
DENTAL PULP STEM CELLS (DPSC)

- *Gronthos et al (2000)* –reported for the first time the presence of stem cells in the dental pulp of adults (adult third molars)

  Those cells transplanted to imunosupressed mice developed dentin-pulp –like structure
- *Gronthos et al (2002)* – in this way they generated dentin with attached pulp
- *Otaki et al (2007)*- DPSC can generate bone, what´s more after being frosted for two years

DENTAL PULP STEM CELLS (DPSC)

Role of 3D scaffolds (spongeous collagen, porous ceramic, fibrous titanium mesh)



Dental tissue engineering – the scaffold could be sterile root canel inside of which new pulp could be recreated

MESENCHYMAL STEM CELLS FROM DENTAL PULP OF EXFOLIATED DECIDUOUS TEETH (SHED)

Miura M et al(2003) presented the existence of multipotent mesenchymal-type stem cells in the dental pulp of the deciduous teeth

In vitro – neuro-like cells, odontoblasts, osteoblasts, adipocytes

After transplantation to mice they produce dentin and bone, in contrast to DPSC they are not able to form dentin-pulp complex

MESENCHYMAL STEM CELLS FROM DENTAL PULP OF EXFOLIATED DECIDUOUS TEETH (SHED)

Cordeiro et al(2008): stem cells from deciduous teeth could be ideal source for reparing damaged teeth or for the induction of bone formation

In the future therapeutic approaches the restoration of damaged dentin and pulp could be succesful with the use of antalogous stem cells of the decidous dentition, which could have been previously extracted and preserved

MESENCHYMAL STEM CELLS FROM THE PERIODONTAL LIGAMENT (PLSCS)

Periodontal ligaments can be isolated from the root of extracted teeth

Seo et al (2004) periodontium contains stem cells , which can differenciate into cementum and alveolar bone

Sonoyama(2006) PDLS+SCAP from the 3rd molars , seeded in scaffold and transplanted into alveolar bone of young pig ⇨ formation of root

and periodontium , able to suport artificial crown

MESENCHYMAL STEM CELLS FROM THE PERIODONTAL LIGAMENT (PLSCS)

Orciani et al (2009) – PLSCS were differentiate in osteoblast with high production of Ca and nitric oxid

New method for treatment of periodontal lesions

MESENCHYMAL STEM CELLS FROM DENTAL FOLLICLE (DFSC)

Isolated from the folicle of 3rd molars, there are able to form cementum and periodontal ligament in vivo (mice)

New tool for development of regenerative therapies and reconstructive treatments

MESENCHYMAL STEM CELLS FROM APICAL PAPILLA (SCAPS)

Stem cells isolated from the upper dental papilla, which is the preccursor tissue of the dental pulp

Sorce : 3rd molars and teeth with open apices

Can be differentiated into osteoblasts and odontoblasts, higher differentiation rate, efficient in combination with others stem cells

Could regenerate the root/periodontal ligament complex

The regenerative endodontic therapy

DENTAL TISSUE ENGINEERING

- Cooperation of dental mesenchymal and epithelial cells needed

DENTAL TISSUE ENGINEERING

- *Honda et al(2007)*
- *Hu et al(2006)*

Formation of separate independent layers and their differentiation in odontoblast and ameloblasts

DENTAL TISSUE ENGINEERING

- *Nakao et al(2009)*

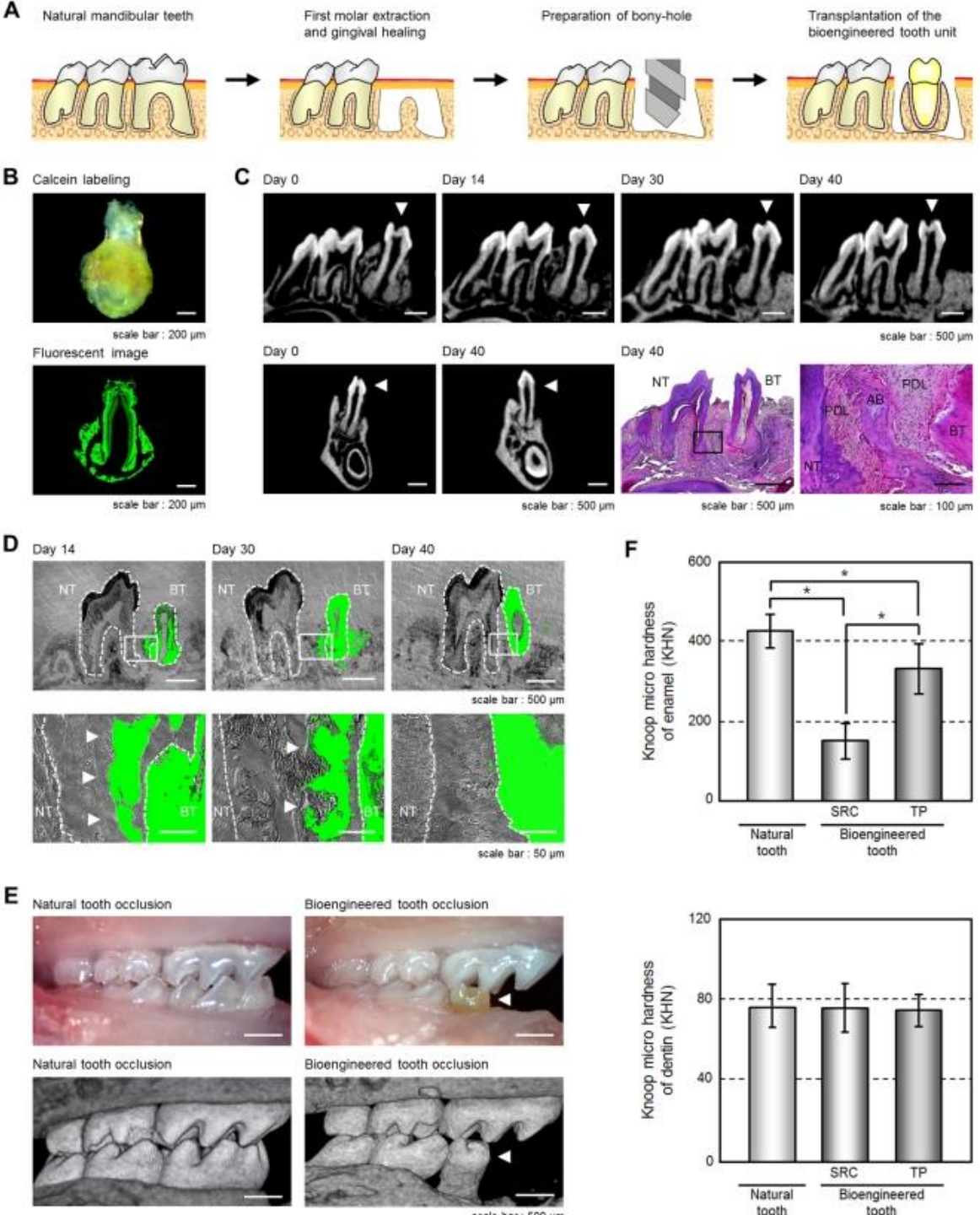
When formed on ectopic side does not developed complete root and periodontium, when implanted into mouse mandible , the shape of tooth was correct

Ikeda et al (2009) the bioengineered tooth had the correct construction and hardness

It respond to experimental orthodontic treatment

DENTAL TISSUE ENGINEERING

- *Oshima et al(2011)*


A
Natural mandibular teeth
First molar extraction and gingival healing
Preparation of bony-hole
Transplantation of the bioengineered tooth unit
B
Calcein labeling
scale bar : 200 μm
Fluorescent image
scale bar : 200 μm
C
Day 0
Day 14
Day 30
Day 40
scale bar : 500 μm
Day 0
Day 40
scale bar : 500 μm
Day 40
NT
BT
scale bar : 500 μm
PDL
AB
BT
NT
scale bar : 100 μm
D
Day 14
Day 30
Day 40
NT
BT
scale bar : 500 μm
scale bar : 50 μm
E
Natural tooth occlusion
Bioengineered tooth occlusion
Natural tooth occlusion
Bioengineered tooth occlusion
F
Knoop micro hardness of enamel (KHN)
600
400
200
0
*
*
*
SRC
TP
Natural tooth
Bioengineered tooth
Knoop micro hardness of dentin (KHN)
120
80
40
0
SRC
TP
Natural tooth
Bioengineered tooth

DENTAL TISSUE ENGINEERING IN HUMAN

- *d´Aquiono (2009)* – restoration of bone loss in the lower jaw in human with the implantation of a bio-complex of adult dental pulp mesenchymal stem cell and a collagen sponge

HUMAN BIOTOOTH?

Dental epithelial stem cels are lost aftter eruption of teeth

Solution could be use of artificial crown, which will be supported for a teeth originating for the mesenchymal stem cells

Even though most of these modalities are still in infancy , it is evident, 21st century dentist is going to play a critical role in the field of medicine