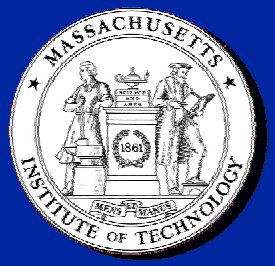
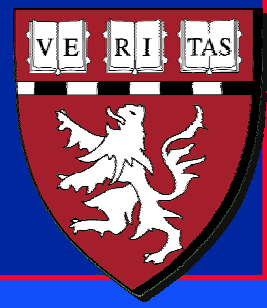


Massachusetts Institute of Technology
Harvard Medical School
Brigham and Women's/Massachusetts General Hosp.
VA Boston Healthcare System



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DENTAL TISSUE REPLACEMENT AND REGENERATION

M. Spector, Ph.D. and I.V. Yannas, Ph.D.

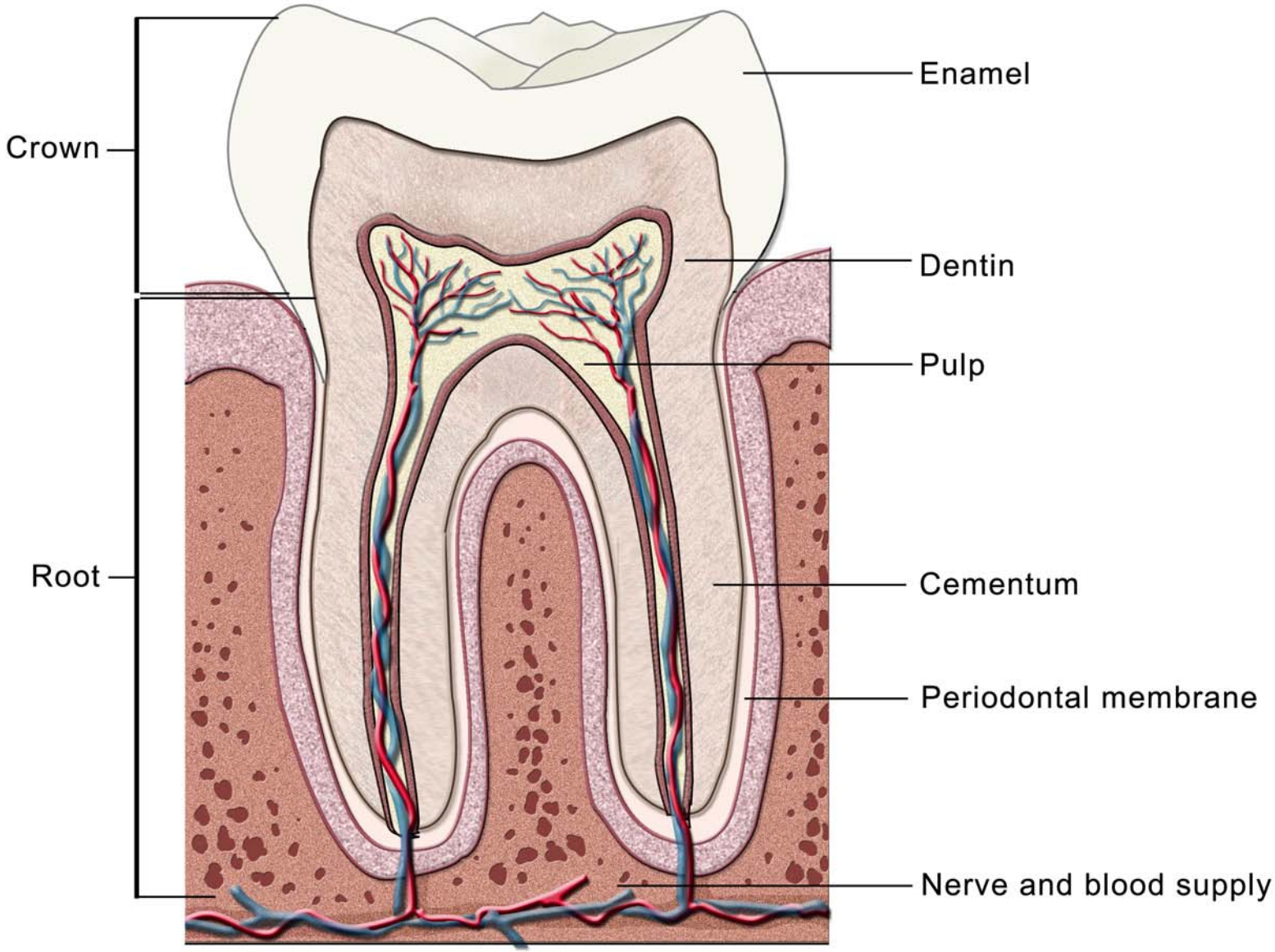


Image source: OCW

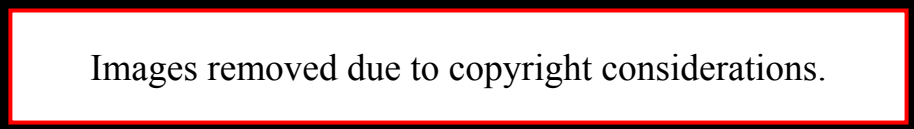
Dental Implant Designs and Materials

Sapphire

Alumina

Titanium

Carbon



Alumina

Carbon

Alumina

Blade Implant

Images removed due to copyright considerations.

“Commercially pure” Titanium

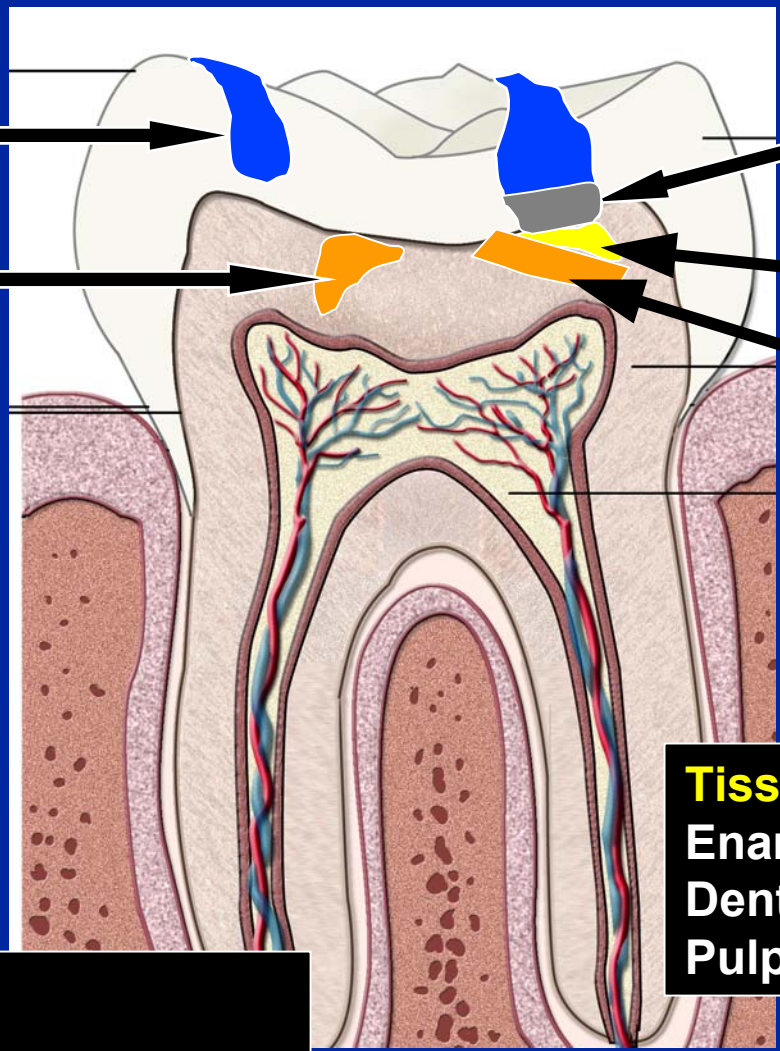
Two-Stage Design;
to shield the artificial root from loading during the initial stage of healing

Images removed due to copyright considerations.

Dental Implant Designs and Materials

Hydroxyapatite-Coated Implants

Images removed due to copyright considerations.



Tissue Engineering
Enamel Regeneration
Dentin Regeneration
Pulp Regeneration

Restorative Materials
Ceramics: porcelain
Metals: amalgam, Implants
Polymer: composite, gutta percha

ELEMENTS FOR TISSUE REGENERATION/ENGINEERING

CELLS	Autologous, Adult (pulp and bone marrow stromal stem cell)
MATRIX	Collagen-GAG
CYTOKINES	Regulation of phenotype Matrix biosynthesis

Tissue Engineering of Complex Tooth Structures on Biodegradable Polymer Scaffolds

- Cells dissociated from porcine third molar tooth buds.
- Cells seeded onto PLA fiber mesh and implanted in rats for 20 to 30 wks.
- Resulting tooth structures contained dentin (odontoblasts), a well-defined pulp chamber, putative cementoblasts, and a morphologically correct enamel.
- Results suggest the presence of epithelial and mesenchymal dental stem cells in porcine third molar tissues.

C.S. Young, et al. *J Dent Res* 81(10): 695-700, 2002

Growth of Porcine Enamel-, Dentin-, and Cementum-Derived Cells in Collagen-GAG Matrices *In Vitro*

Unerupted Porcine Premolars and Molars

- Lower mandibles from 6-month old pigs.
- In aseptic environment, mandibles were split in half, soft tissue removed, and overlying bone from lingual side chiseled away.
- Exposed teeth were excised and gingiva removed.

Marty-Roix R, *et al.*, Tiss. Engr. (In press)

MATERIALS AND METHODS
Cell Isolation

Dentin - from developing cusp tips. Mineralized enamel removed and pulp cut away.

Enamel - Mineralized enamel removed from cusp tips and chiseled into small pieces.

Cementum - from erupted 2nd molars and unerupted premolars. Chiseled away from tooth and into smaller pieces. Pulp removed with sterile gauze.

Pulp - from base of teeth and cut into small pieces with scalpel.

MATERIALS AND METHODS
Methods of Cell Culture

- **Cell Isolation from Digested Tissue**
  - Tissue digested for 12 hours in collagenase.
  - Suspension filtered, and cells plated into tissue culture dishes.
- **Explants/Cell Outgrowth**
  - Small pieces of tissue plated onto tissue culture dishes.

COLLAGEN-GAG MATRICES

- Type I (bovine tendon)
- Type II (porcine)
- Chondroitin 6-sulfate

1mm

- Freeze-dried
- Dehydrothermally cross-linked

500μm

IV Yannas, *et al*. PNAS, 1989

Cell Cultures at Confluence; Digested Tissue

Ameloblasts

Pulp Cells

Images removed due to copyright considerations.

Cementoblasts

Odontoblasts

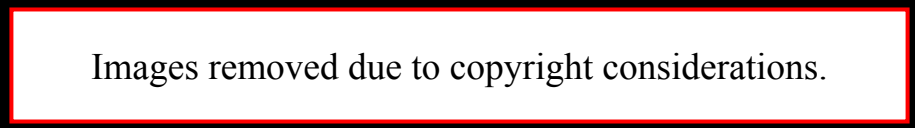
DENTAL TISSUES
Tissue-Specific Matrix Molecules

- **Enamel** — Amelogenin
- **Dentin** — Dentin Matrix Protein-1
- **Cementum** — ?
- **Pulp Cells** — ?

Amelogenin Immunohistochemistry

Amelogenin

Pre-ameloblasts **Negative Control**



Dentin

Odontoblasts

Amelogenin Immunohistochemistry; Passage 1

Ameloblasts; Digested Tissue

Ameloblasts;
Outgrowth from Explants

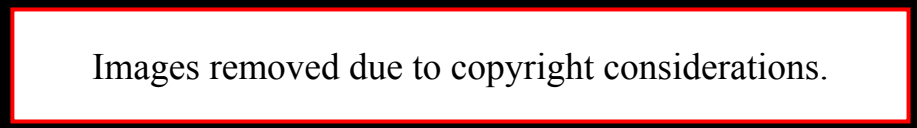
Images removed due to copyright considerations.

Neg. Control

Neg. Control

1 day

Amelogenin Immunohistochemistry of Ameloblast-Seeded Collagen-GAG Matrices



7 days

Images removed due to copyright considerations.

1 day

DMP-1 Immunohistochemistry of Odontoblast-Seeded Collagen-GAG Matrices

7 days

28 days

SUMMARY

- Cells can be isolated from digested tissue and grown from explants: enamel, dentin , cementum, and pulp.
- Cells display distinctive characteristics.
- Ameloblasts expanded in monolayer and grown in collagen-GAG matrices express amelogenin.
- Odontoblasts in collagen-GAG matrices express DMP-1