

# Skin Tissue Engineering: Your Epidermis is Showing !



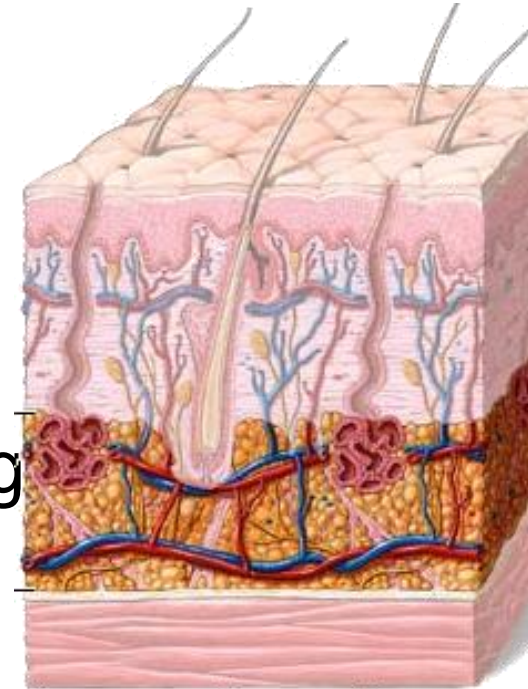
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**Acknowledgements to: Andrew Brown, Amy Chaya,  
and Trisha Pavel  
University of Pittsburgh**



# Why Study Skin ?

- Skin is arguably the most injured organ
- How many of you have ever had a cut or a scrape ?
- Did your cut heal perfectly ?
- Did you cut heal with a scar ?
- Some injuries heal poorly or are disfiguring
  - Burn-related skin grafts
  - Skin ulcerations





# What's Cool About Skin ?

## Skin serves many functions:

- Physical barrier from outside environment
- Protects body from UV radiation ( sunlight )
- Protects body from infection
- Protects underlying tissue from mechanical shocks
- Prevents water loss
- Regulates body temperature

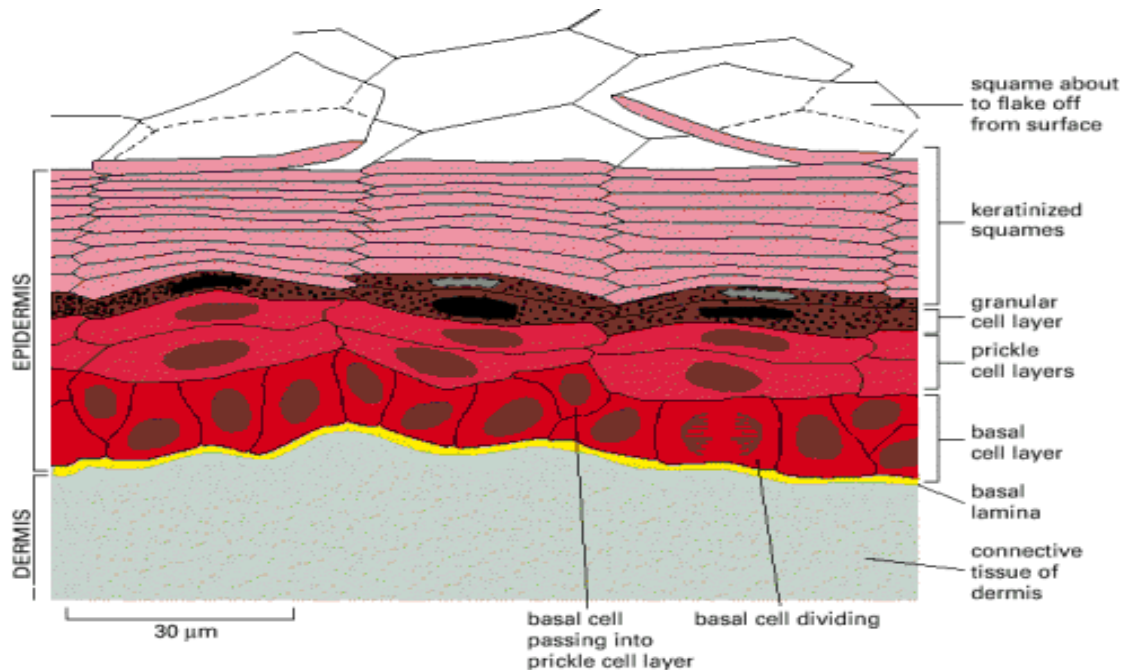
## Skin has many different components:

- Epidermis – hair shaft, sweat pores
- Dermis – hair follicle, sweat gland, blood vessels
- Subcutaneous – fatty tissue

# Skin Layers

## 1. Epidermis

- Dead outer layer replenished by basal cells ( SCs )
- Granular cells form barrier against water
- Melanocytes ( pigment ) protect from UV rays
- Dendritic cells protect



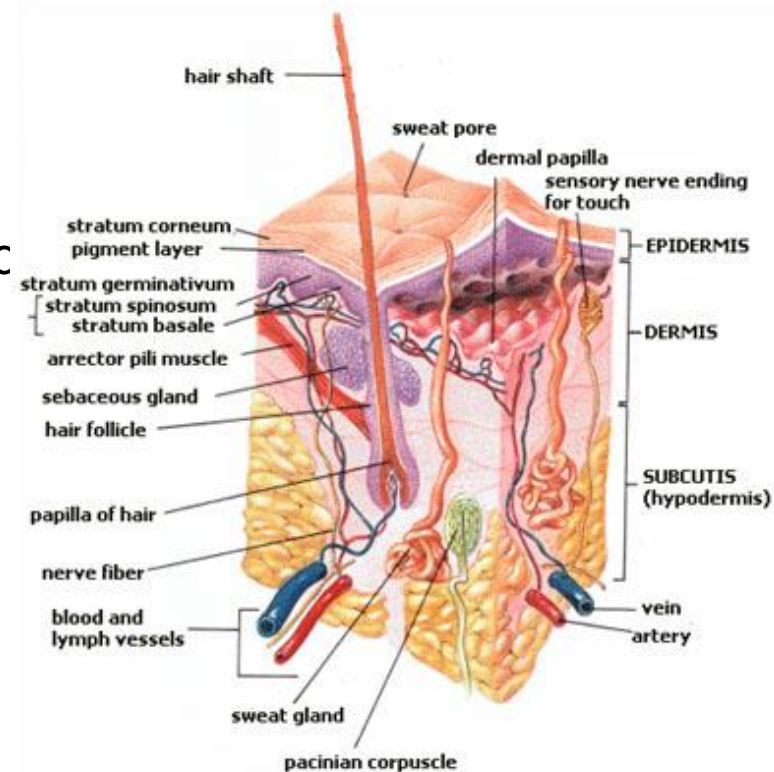
# Skin Layers

## 1. Dermis

- Contains sensory nerve endings
- Provides blood supply to epidermis
- Contains hair follicles and sweat glands

## 2. Hypodermis ( Fatty Layer )

- Anchors skin to muscle and bone
- Cushions body from bumps
- Insulates body from heat and cold





# Properties of Skin

What else is skin tissue made up of ?

## EXTRACELLULAR MATRIX

- Collagen – strong structural support
- Elastin – elasticity and flexibility
- Keratin – tough waterproof fibers



## Activity

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# Skin Epidermal Layer Synthesis



# Problem

Your tissue engineering company needs to develop a skin model to allow early-stage testing of TE scaffolds prior to use in humans

Using the principles we discussed keep in mind what is important for skin to carry out its many important functions

1. Put on gloves !!!
2. Part A and Part B of ECM material and several growth factors have been provided
3. Add your desired growth factors to Part A of your ECM ( A little goes a long way )
4. Add the appropriate cellular components and blood vessels to Part A
5. Pour Part B into Part A and mix very thoroughly
6. After mixing for two minutes pour into the plastic containers provided

# What Types of Skin Injuries Occur ?



Sutures



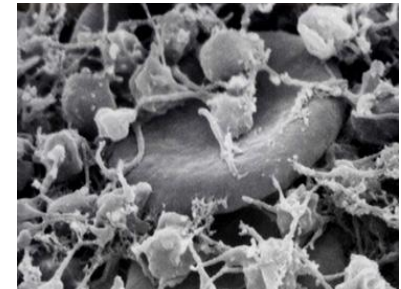
Tissue  
Scaffolds





# How Does Skin Heal ?

- Skin tissue regeneration
- Scar tissue formation
  
- Inflammation
  - Blood Clotting and Immune Attack
- Migration and Proliferation
  - New BV and temporary fibers produced
- Remodelling
  - New and better ECM produced





# How Does Skin Heal ?

- Autograft– taken from patient
- Allograft– taken from donor/cadaver
- Xenograft–taken from animal

- Biocompatible
- Biodegradable
- Porous





# When is Skin Grafting Necessary ?

Skin grafting can be used to treat:

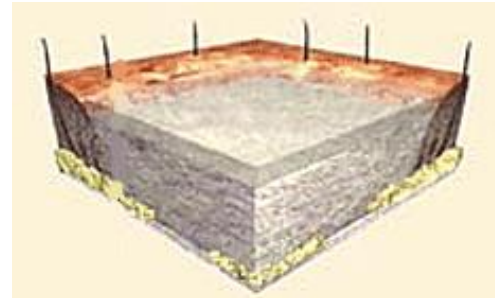
- Extensive wounding or trauma
- Burns
- Areas of prior infection with extensive skin loss
- Specific surgeries that may require skin grafts for healing to occur

## Tissue Engineering



# Artif. Skin Graft Structure (Integra®)

- Semi-permeable silicone membrane
  - Controls water vapor loss
  - Provides a flexible adherent covering
  - Adds increased tear strength
- Collagen-GAG biodegradable matrix
  - Provides a scaffold for cellular invasion and capillary growth
  - Scaffold is eventually remodeled as the patient's cells rebuild the damaged site





# Skin Graft Considerations

- Post-graft functionality:
  - What are skin's important characteristics ?
  - Will the graft adequately provide these characteristics ?
- Post-graft appearance:
  - Does the graft look like natural skin ?
- Immunogenicity:
  - Will the graft cause an unwanted immune response ?
- Biocompatibility:
  - Does the graft scaffold biodegrade naturally ?
  - Are there any harmful biodegradation products ?



# Activity

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## Skin Grafting Surgery



Your company now needs to test a TE scaffold in the model you developed prior to implantation in Lebron James

Using the principles we discussed, keep in mind what is important for a TE scaffold to allow regeneration of the skin



# Procedure

1. Put on gloves !!
2. Cut your scaffold into an appropriate size for your wound bed
3. Determine whether your graft is the appropriate thickness
4. Mix parts A and B of the surgical glue and place into wound bed
5. Place your scaffold into the wound bed and cover with a layer of surgical glue



# Components of Skin

## 1. Epidermis

- Keratin- waterproof barrier; strength

## 2. Dermis

- Elastin- allows skin to stretch and then resume shape
- Collagen- mechanical strength



# Student Activity

## Goal:

**Test the mechanical strength and/or elasticity of our skin scaffold and compare it to chicken skin.**



# Student Activity

## Purpose:

- To gain an understanding of mechanical and elastic properties of our scaffold and chicken skin.
- Use this understanding to realize how elastic and mechanical properties are important to skin and tissue engineering.





# Student Activity

**Procedure:** **Wear goggles and gloves (for chicken)**

- 1. Measure the length of the scaffold before weights are attached.**
  - Record original length**
- 2. Attach hanging weights to skin scaffold/chx skin**
  - 200g, 300g, 500g**
  - Find and record the force of each mass.**
- 3. Measure the stretched length of the scaffold, record.**
- 4. Find the final length (original – stretched).**
- 5. Graph your results**
  - X-axis: elongation Y-axis: Load (Force)**



# Student Activity

## Questions/Reflection

- 1. Aside from the skin, where in the body is elastin located?**
- 2. What causes/exacerbates the degradation or breakdown of proteins found in the skin (i.e. collagen)?**