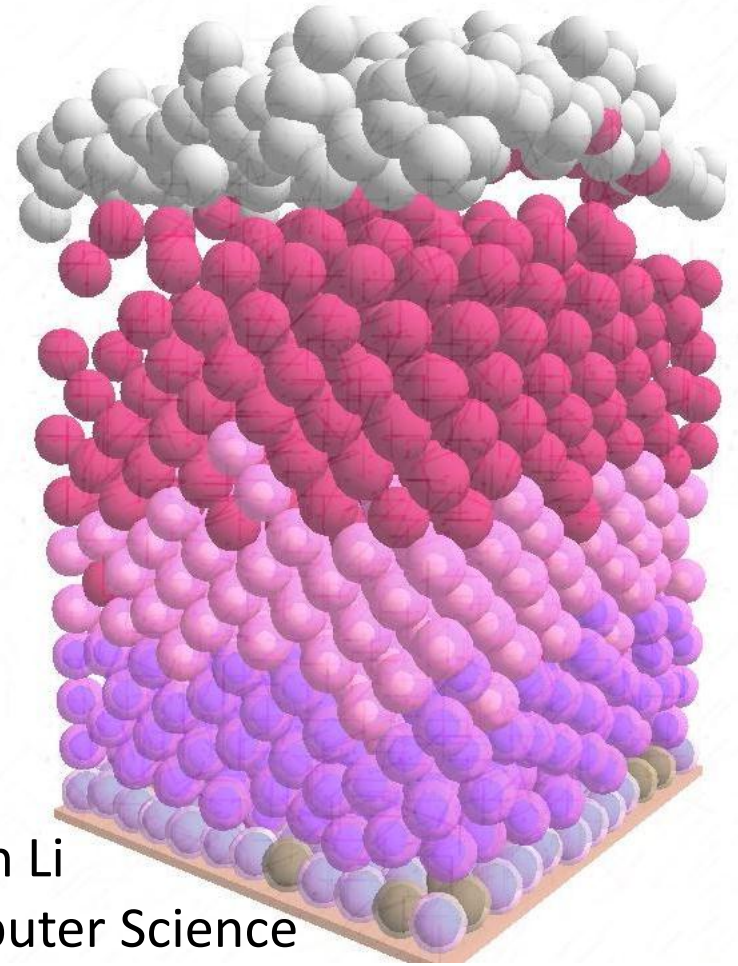
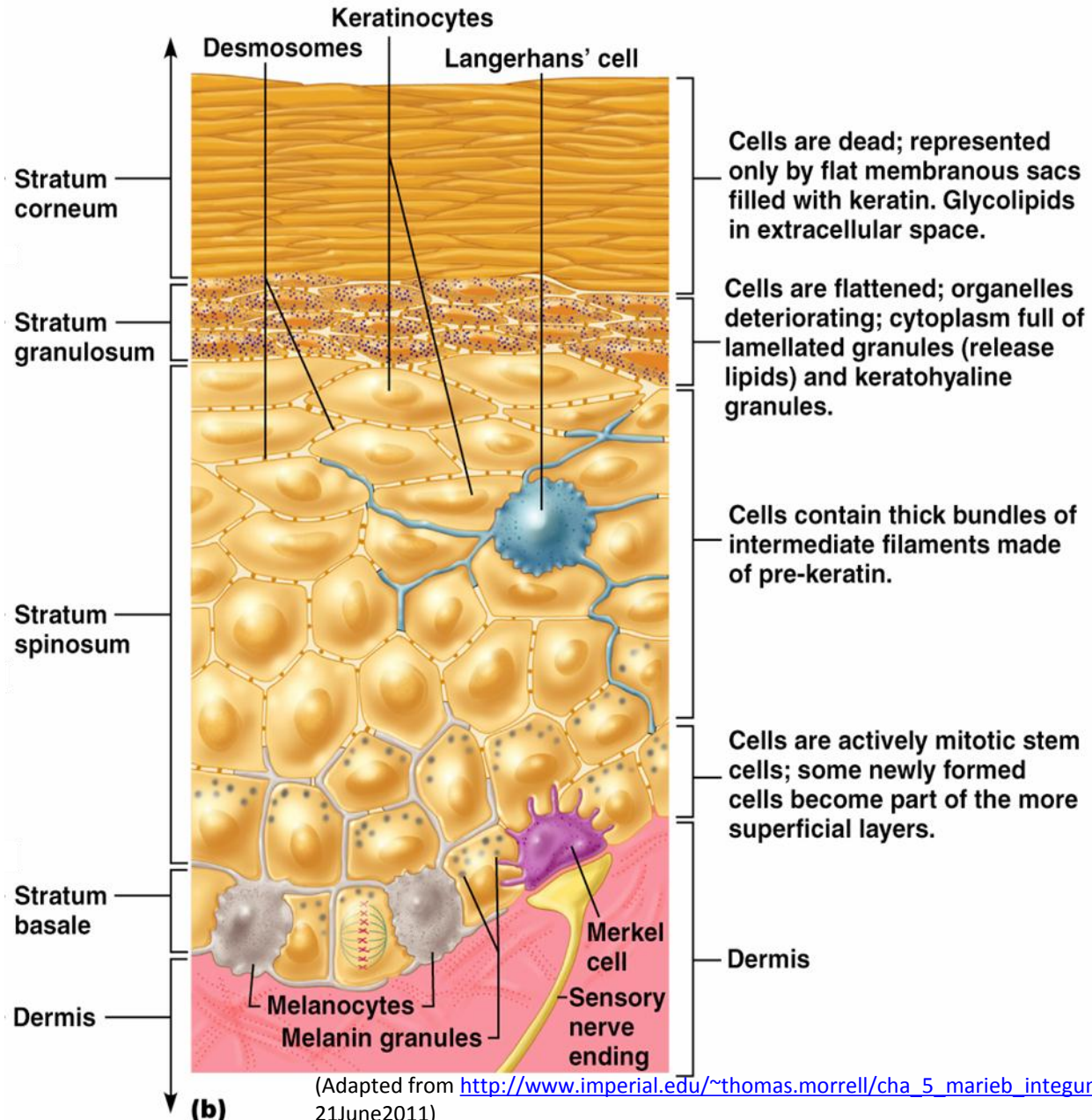


Coupled in vitro and computational model of the skin



Dr Shannon Li
Department of Computer Science
Kroto Research Institute
23 Feb 2012

Skin



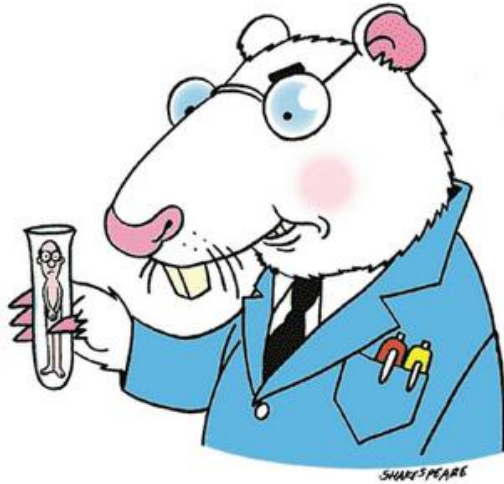
(Adapted from http://www.imperial.edu/~thomas.morrell/cha_5_marieb_integumentary.htm on 21June2011)

Skin disease

- Atopic dermatitis (eczema)
 - 15%-20% children in developed countries
- Psoriasis
- Ichthyosis vulgaris
- Epidermis blistering disorders

How to study the skin

www.johnshakespeare.com.au



<http://thereconditequetzal.wordpress.com/2010/10/>



<http://www.pgbeautygroomingscience.com/innovations-in-technology-clinical-testing.html>



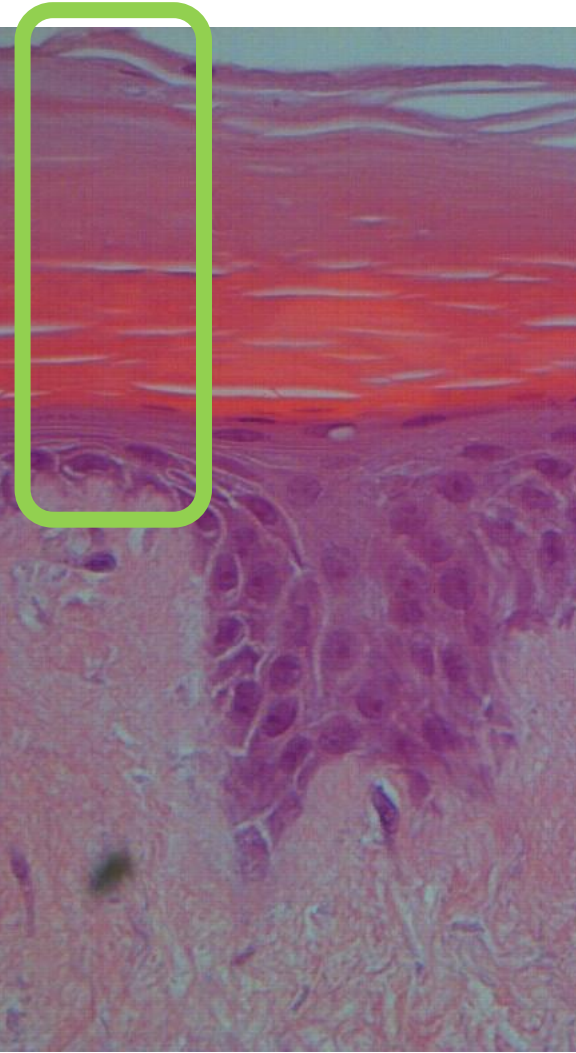
Copyright 2003 Randy Glasbergen. www.glasbergen.com










<http://www.ecademy.com/node.php?id=157022>

Agent-based model

- Each cell = single entity (sphere)
- Rules define cell behaviour and interaction with neighbours, governed by environment (nutrients)
- Effect of physical forces
- FLAME

Agent types

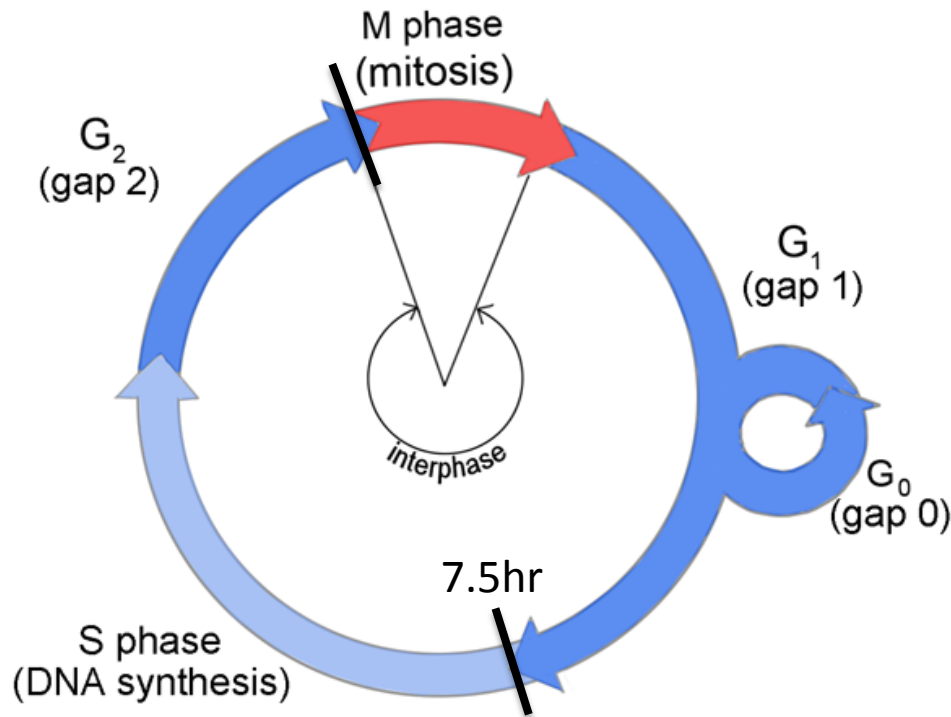


	Agent type	Colour code
Keratinocyte agent	Type 0: Stem Cell	
	Type 1: Progenitor Cell	
	Type 2: Stratum Spinosum Cell	
	Type 3: Stratum Granulosum Cell	
	Type 4: Stratum Corneum Cell	
	Type 5: Skin flake (dead cell)	  10um (Koehler et al. 2011)
Basement membrane agent	Type 10: Surface tile / basement membrane	  200um

(Bullock, A. , experiment, 2011)

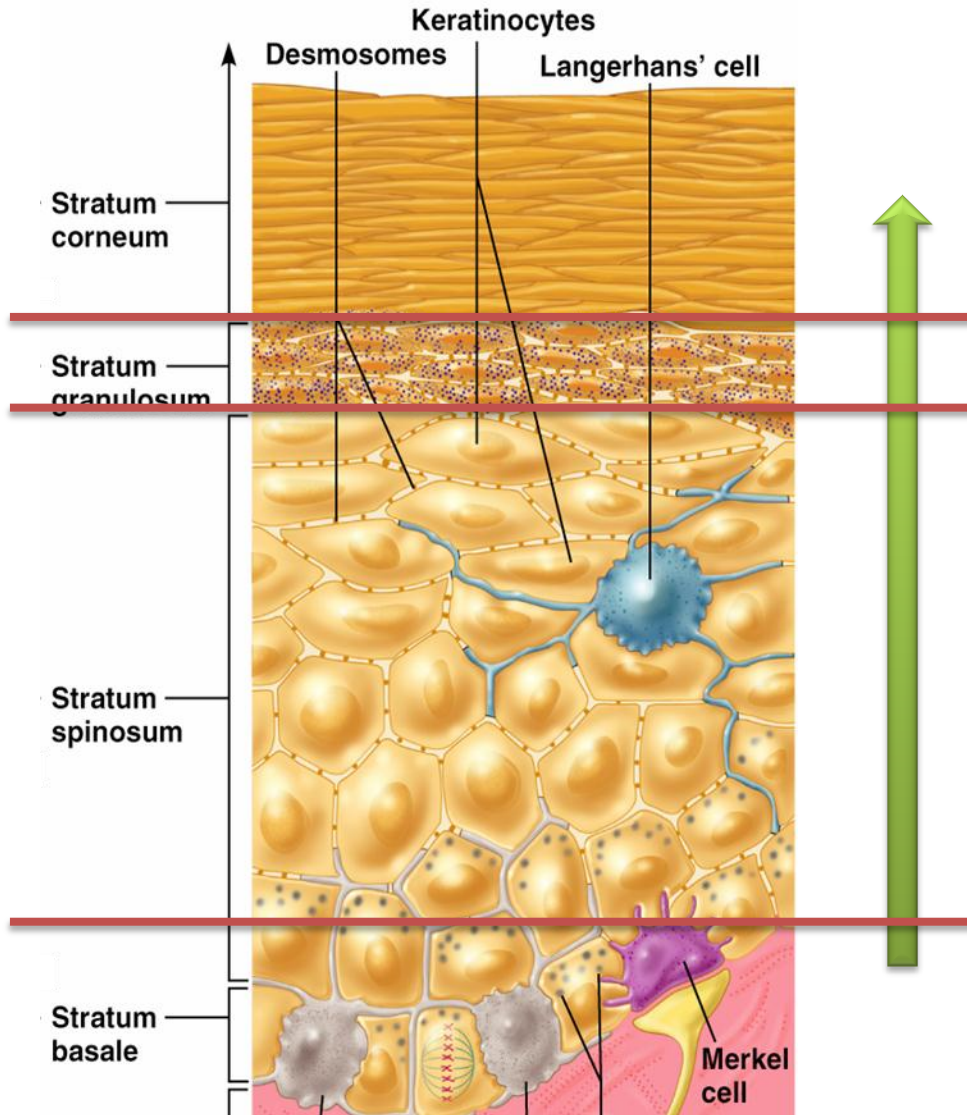
Biological rules – cell cycle

- Only basal cells (stem cell and progenitor cell) can divide



```
If (half way through cycle) {  
    Do G1 check  
  
    if (environment suitable) {  
        proceed  
    } else {  
        wait in G0  
    }  
}
```

Biological rules - differentiation



```
If (cell leave basal layer) {  
    basal -> spinosum  
} else if (t==T1) {  
    spinosum -> granulosum  
} else if (t==T2) {  
    granulosum -> corneum  
}
```


Physical forces

- Newton's Second Law

$$m \frac{d^2 \mathbf{u}_i}{dt^2} + c_i \frac{d\mathbf{u}_i}{dt} = \sum_{j=1}^n \mathbf{F}_{ij}$$

- The RHS force term

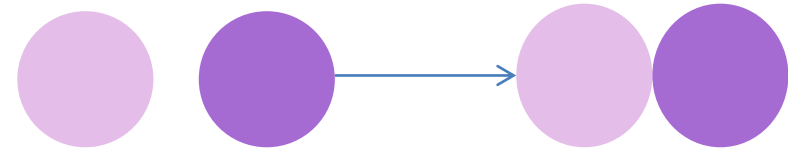
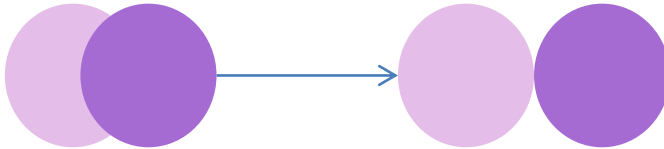
$$\mathbf{F}_{ij} = \mathbf{F}_{ij}^r + \mathbf{F}_{ij}^a$$

Physical rules

Repulsive force

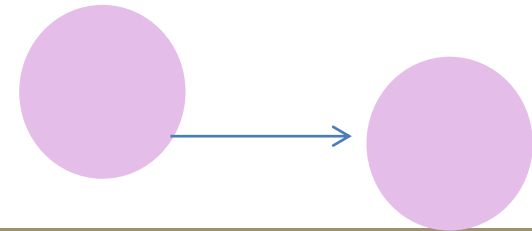
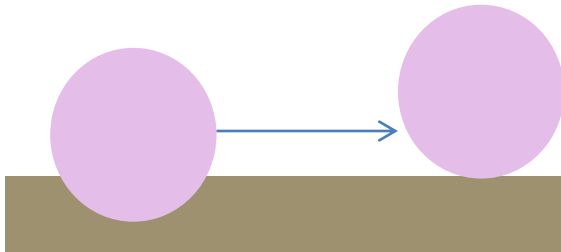
Adhesive force

Cell-cell

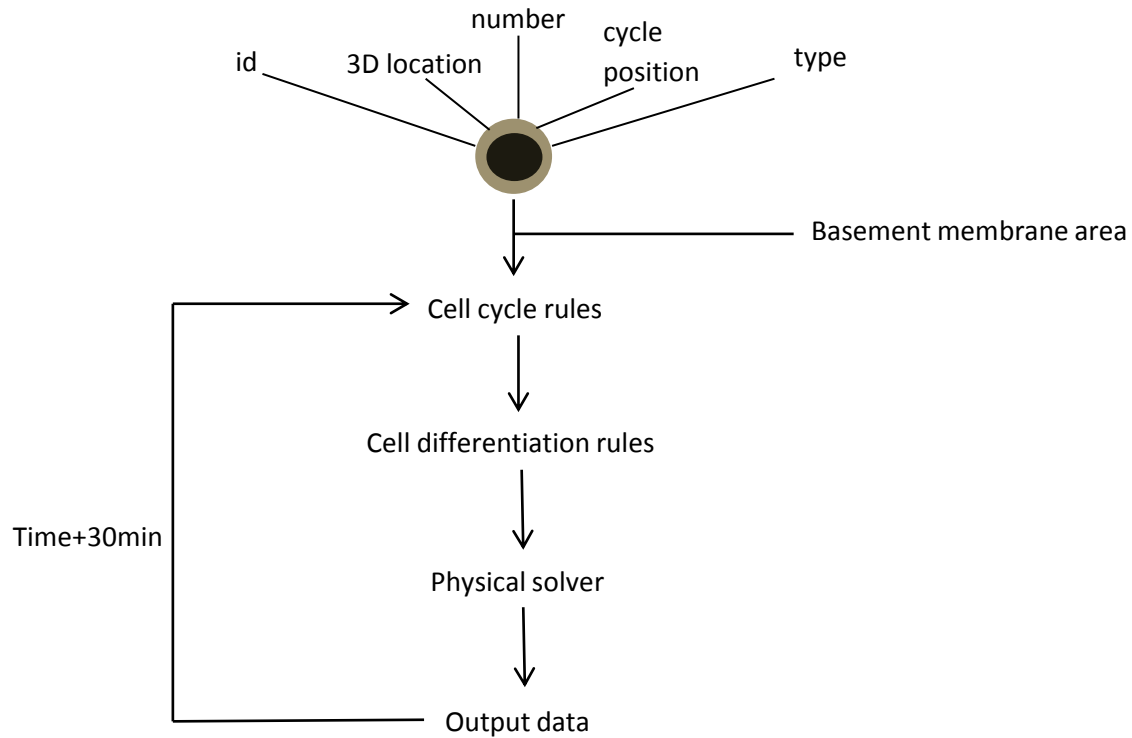


within 5 μ m apart
(Walker, et al. 2010)

Cell-substrate



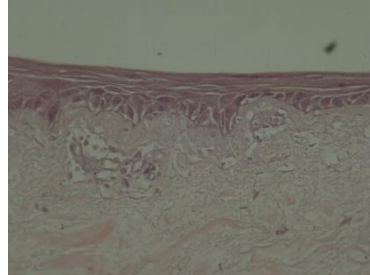
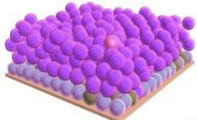
General algorithm



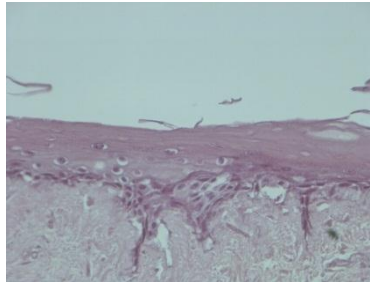
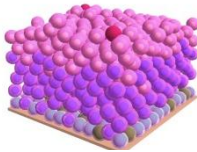
Results

Homeostasis with H&E

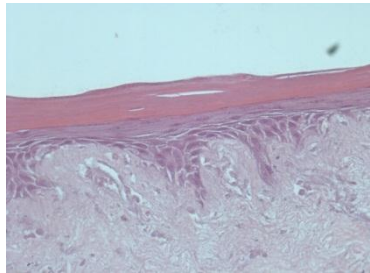
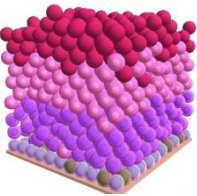
Day 3



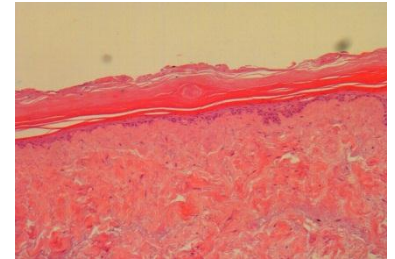
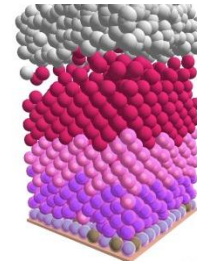
Day 5



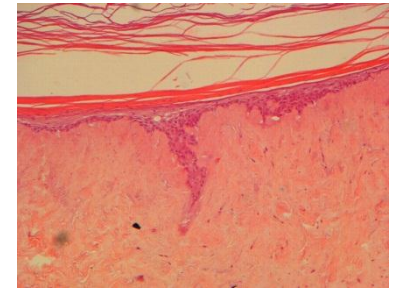
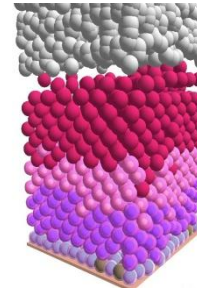
Day 7



Day 14



Day 21



Acknowledgements

- Prof. Sheila MacNeil
- Prof. Rod Smallwood
- Dr. Anthony Bullock