VARSKIN 6

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International RAMP VARSKIN Workshop **March 25th, 2018**	
1300-1315	Overview and Objectives
1315-1445	Intro to VARSKIN and Dose Calcs
1445-1500	**Break**
1500-1600	Exploring the GUI
1600-1700	VARSKIN 6 Improvements

International RAMP VARSKIN Workshop **March 26th, 2018**	
0900-1030	Start Examples
1030-1045	**Break**
1045-1200	More Examples
1200-1300	**Lunch**
1300-1430	NRC Case Study using VARSKIN
1430-1445	**Break**
1445-1600	Discuss V & V, VARSKIN Limitations
1600-1700	VARSKIN Code Discussions and Student Examples

Overview

- The NRC oversees licensee compliance with regulatory requirements specified in 10 CFR 20.1201(c)
- VARSKIN was first developed in 1987 to allow the NRC independent confirmation of skin dose estimates submitted by licensees
  - the code is intended to be used as a tool for calculating tissue dose at depth resulting from radiological contamination of skin
- The current version is VARSKIN 6.0

VARSKIN history

- VARSKIN (Traub et al., 1987)
- VARSKIN Mod 2 (Durham, 1992)
  - → SADDE calculations added (Reece et al., 1989)
- VARSKIN 3 (Durham, 2006)
  - → volumetric-source backscatter factors
  - → basic photon model added
  - → syringe geometry added
- VARSKIN 3.1 (Durham, 2009)
  - → correction of error in photon energy database
- VARSKIN 4 (Hamby et al., 2011)
  - → more rigorous treatment of photon dosimetry
  - → no need for code “installation”
  - → syringe model deleted
- VARSKIN 5 (Hamby et al., 2013)
  - → enhancements to electron dosimetry
- VARSKIN 6 (Hamby et al., 2017)
  - → ICRP 107 and Decay Daughter additions

Objectives

- To become knowledgeable of the general models used for skin dosimetry
- To become knowledgeable of the VARSKIN models employed for photon and electron skin dosimetry
- To gain experience executing the VARSKIN software for skin dosimetry estimation
- To become knowledgeable of VARSKIN's limitations

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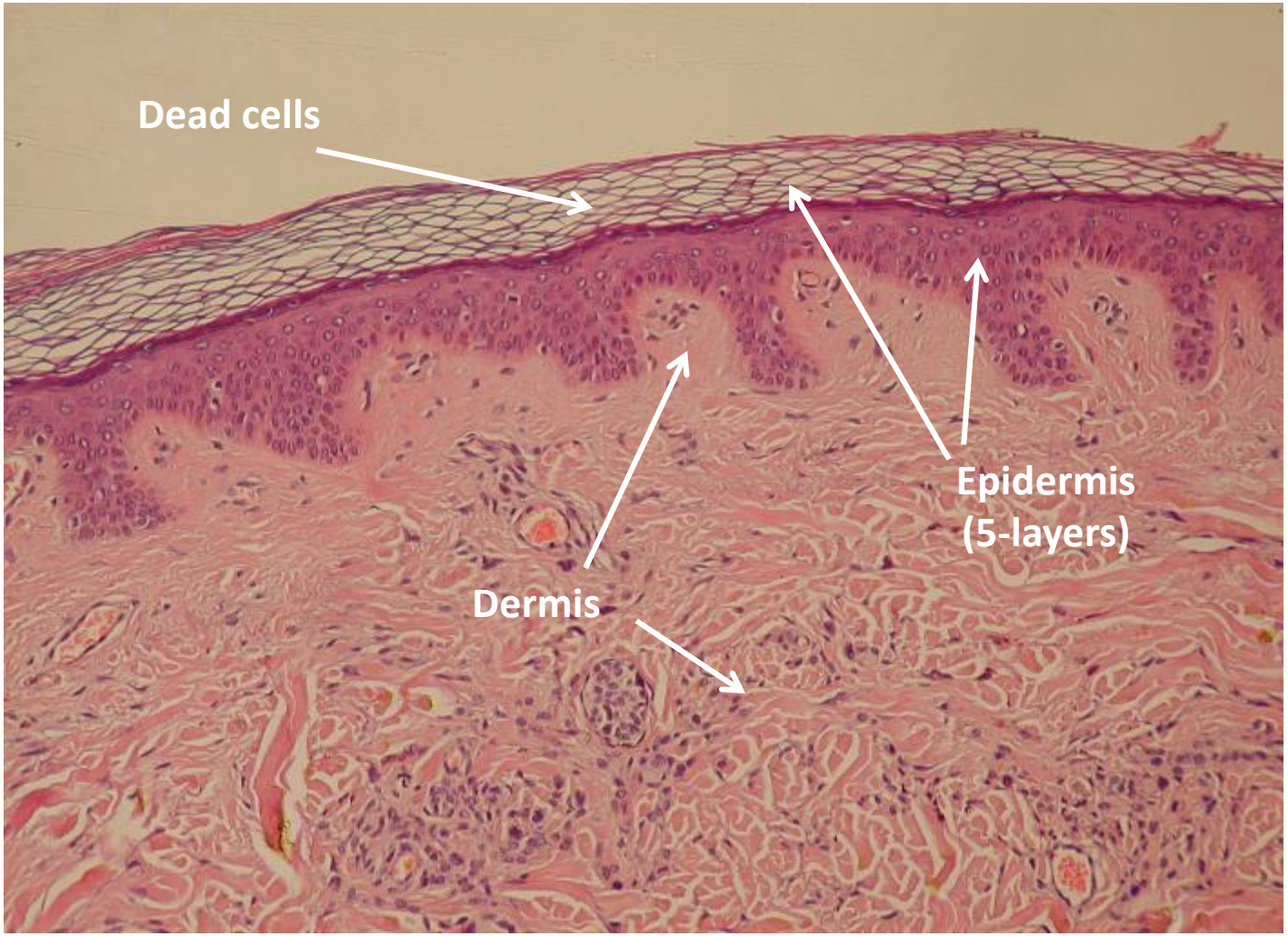
Skin physiology and skin dose limits

Human skin

- The skin is the largest human organ/tissue
  - accounts for about 15% of adult body weight
- Human skin is similar to that of pigs
- Skin provides …
  - physical barrier
    - to protect against external agents
    - to prevent excess water loss
  - thermo-regulation
- Serves a significant role in maintaining homeostasis
- **Dead layer is about 70 μm thick**
  - **i.e., 7 mg/cm^2 for unit-density material**
- Three fundamental living layers:
  - epidermis
  - dermis
  - subcutaneous fat (hypodermis)

Skin layers



Human skin - Epidermis

- The epidermis is a continually renewing layer
- It is a dynamic tissue in which cells are in unsynchronized continuous motion, making their way toward the surface
- Epidermis contains proliferating basal cells
  - undulating thickness from ~100 to ~1500 microns
- Epidermal stem cells in the basal layer are generally long-lived with slow cell cycles
- Wounding, however, can stimulate stem-cell division
- DNA damage can mutate stem cells
- Basal-layer cells migrate to the surface in about 30 days

Dosimetry implications

- Skin thickness (total) ranges between about 500 μm and 14,000 μm
- The energy deposition of most significance will be heavily impacted by hot-particle location
- Thus, calculated dose may or may not provide a true indication of radiation damage to that particular area of exposed skin
- Skin dose is generally limited by the potential for deterministic effects

Historical limits on skin dose

- ICRP 1 (1954) – 600 mR/wk
  - @ 70 μm
- ICRP 9 (1966) – 30 rem/yr
  - averaged over 1 cm^2
- ICRP 26 (1977) – 50 rem/yr
  - 50 – 100 μm
- ICRP 59 (1992) – 30 Gy/lifetime
  - averaged over 1 cm^2
  - deterministic (dermal effects): 300 – 500 μm
    - acute transient ulceration: 100 – 150 μm
  - stochastic (epidermal effects): 20 – 100 μm

Historical limits on skin dose

- ICRP 60 (1991) – 20 Gy/lifetime; 0.5 Sv/yr
  - averaged over 1 cm^2 @ 70 μm
  - deterministic (dermal effects): 300 – 500 μm
  - stochastic (epidermal effects): 20 – 100 μm
- 10 CFR 20 (1991) – 0.5 Sv/yr
  - averaged over 1 cm^2 @ 70 μm
- 10 CFR 20 (2002) – 0.5 Sv/yr
  - averaged over 10 cm^2 @ 70 μm

Limits on HOT particle skin dose

- NCRP 106 (1989) – source limitations
  - to limit acute deep ulceration
  - 10^{10} beta particles emitted
    - equivalent to: ~ 5 Sv, over 1 cm^2 @ 100 – 150 μm
- ICRP 60 (1991) – 0.5 Sv/yr
  - averaged over 1 cm^2 @ 70 μm
- NCRP 130 (1999) – 5 Sv/yr
  - averaged over 1 cm^2 @ 70 μm
  - 0.5 Sv/10 cm^2 for particle on clothing