Your Skin In Our Changing World

Mary L. Williams, M.D.

Clinical Professor of Dermatology and Pediatrics

Univeristy of California San Francisco

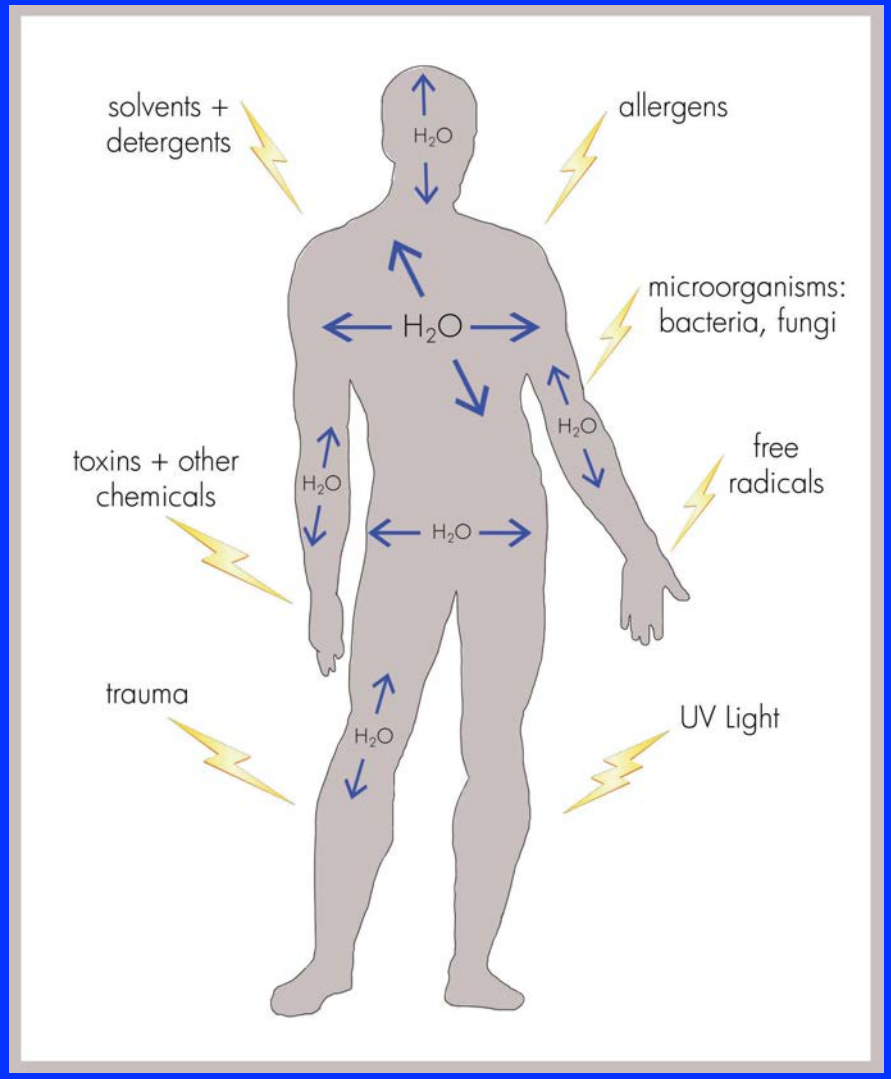
Why Skin?

- Our climate is changing, the world is warming…
- Our health and wellbeing is in trouble…
- What does this have to do with skin?

Skin Is Our First Line of Defense

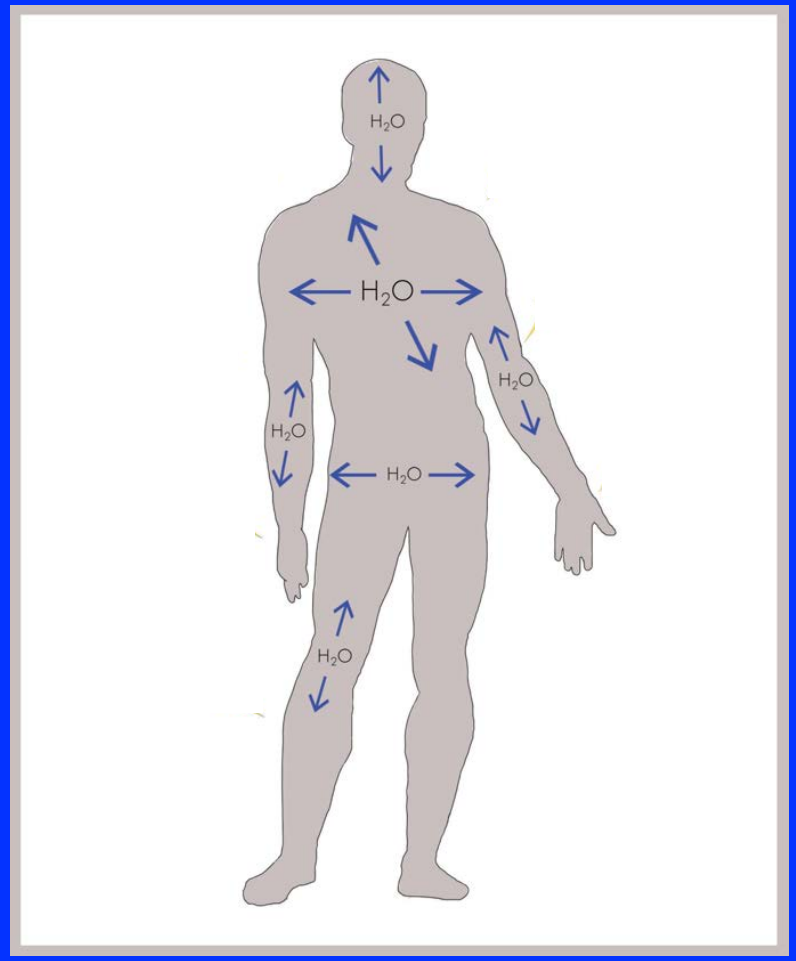
- Skin has many protective functions

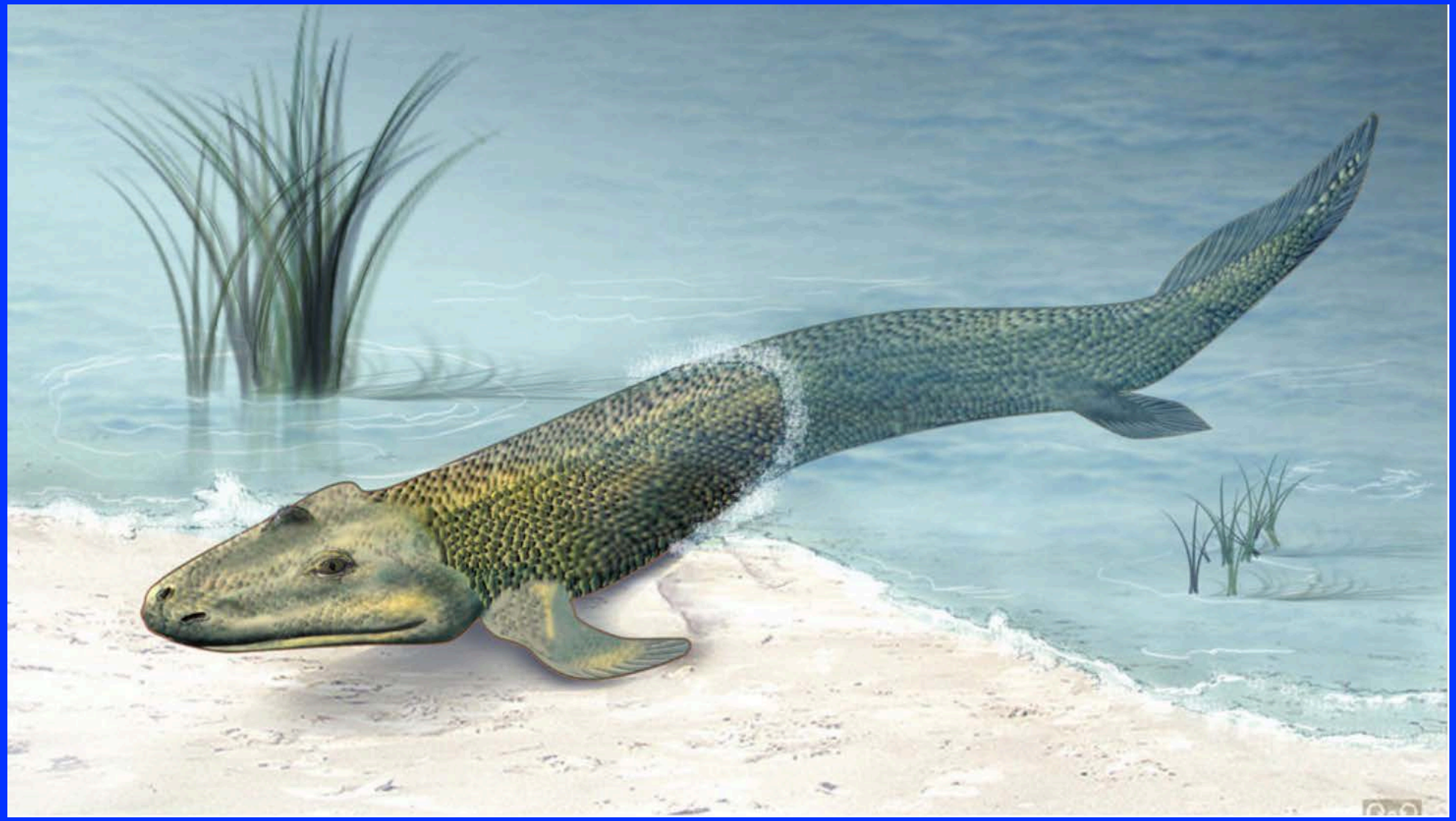
- Skin Keeps
  - the Outside World Out
  - and the Inside World In



Skin Is Our First Line of Defense

- Skin has many protective functions
- Skin Keeps:
  - the Outside World Out
  - and the Inside World In
- Providing a barrier against water loss is No. 1!

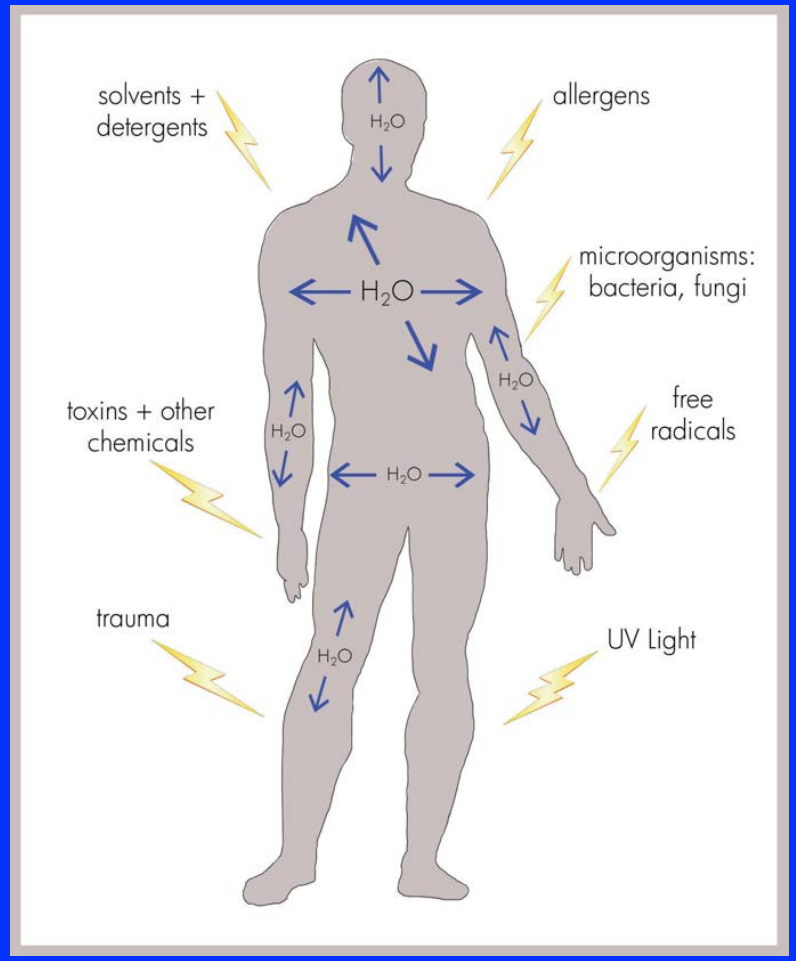


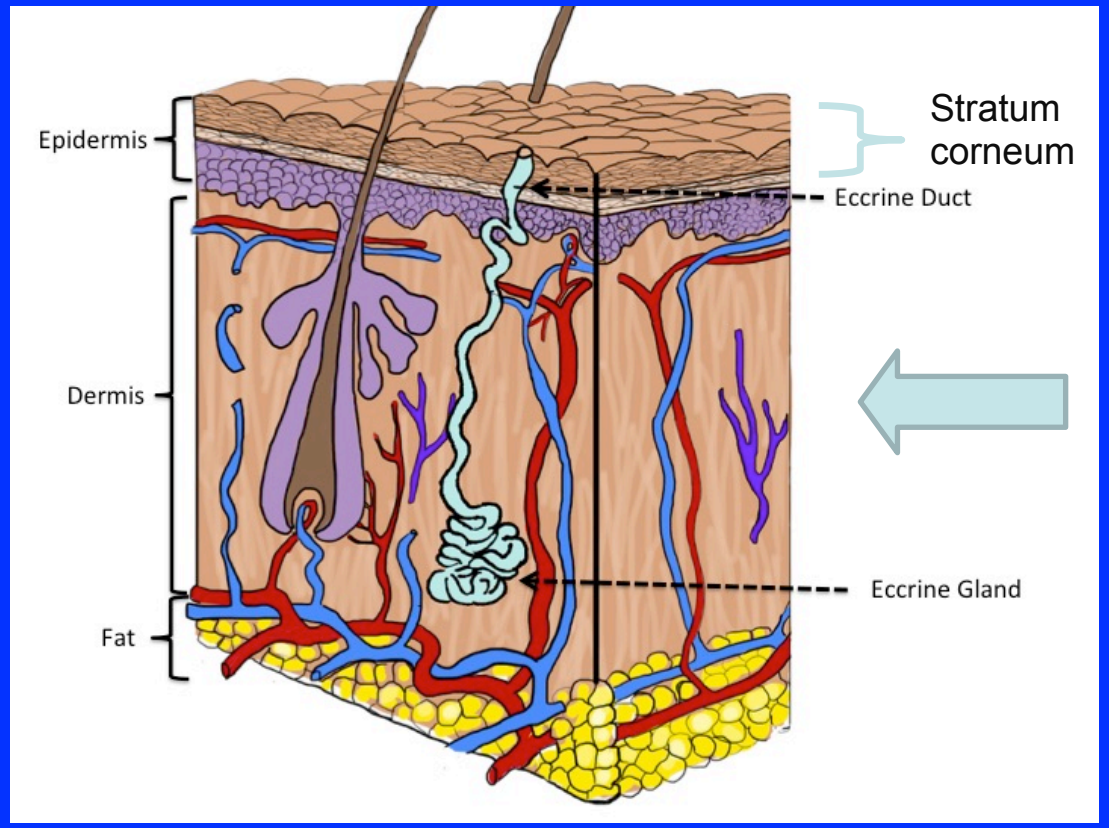


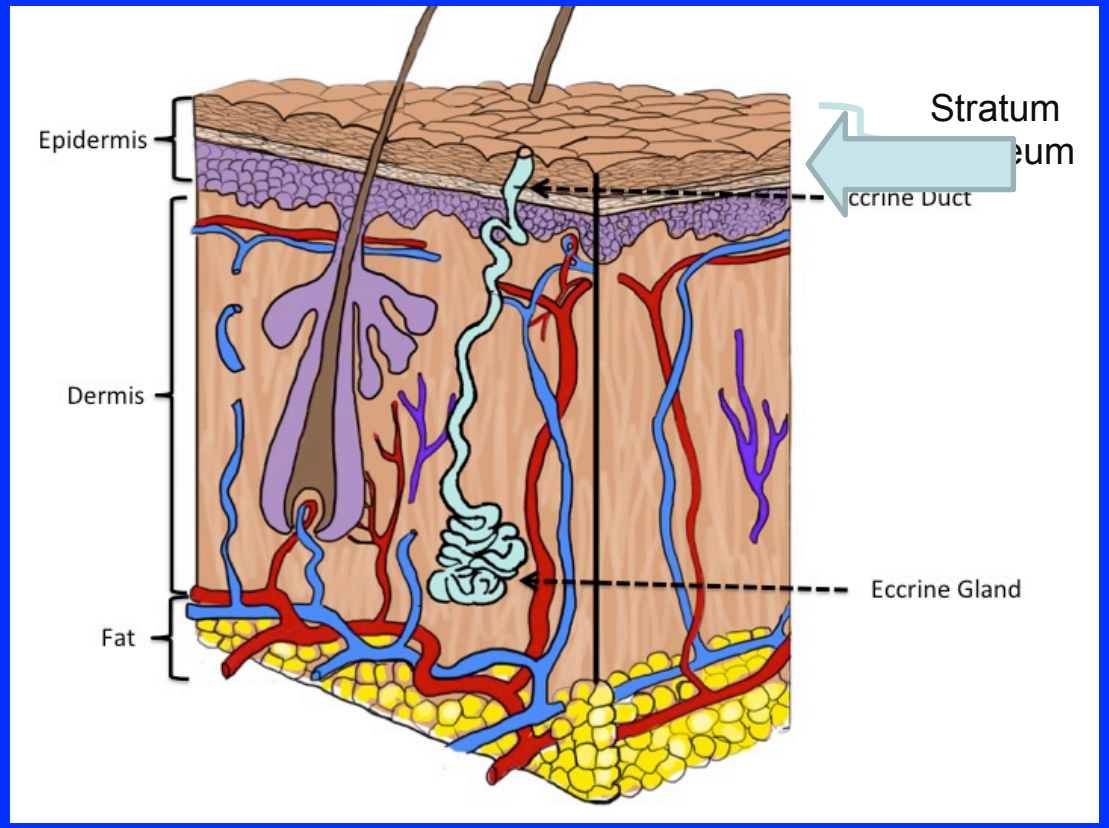
Drawing by Zina Deretsky

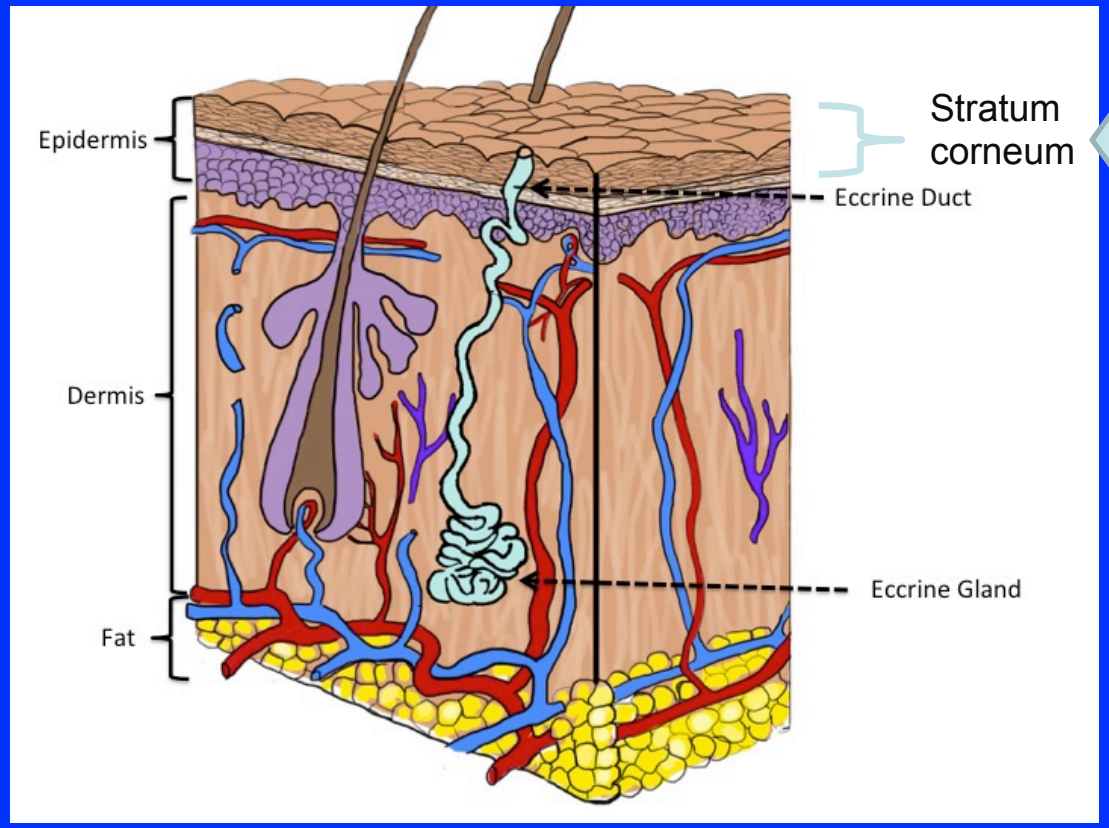
Skin Is Our First Line of Defense

- Skin has many protective functions
- Skin Keeps:
  - the Outside World Out
  - and the Inside World In
- Providing a barrier against water loss is No. 1!
- The Water Barrier is also the barrier to external assaults

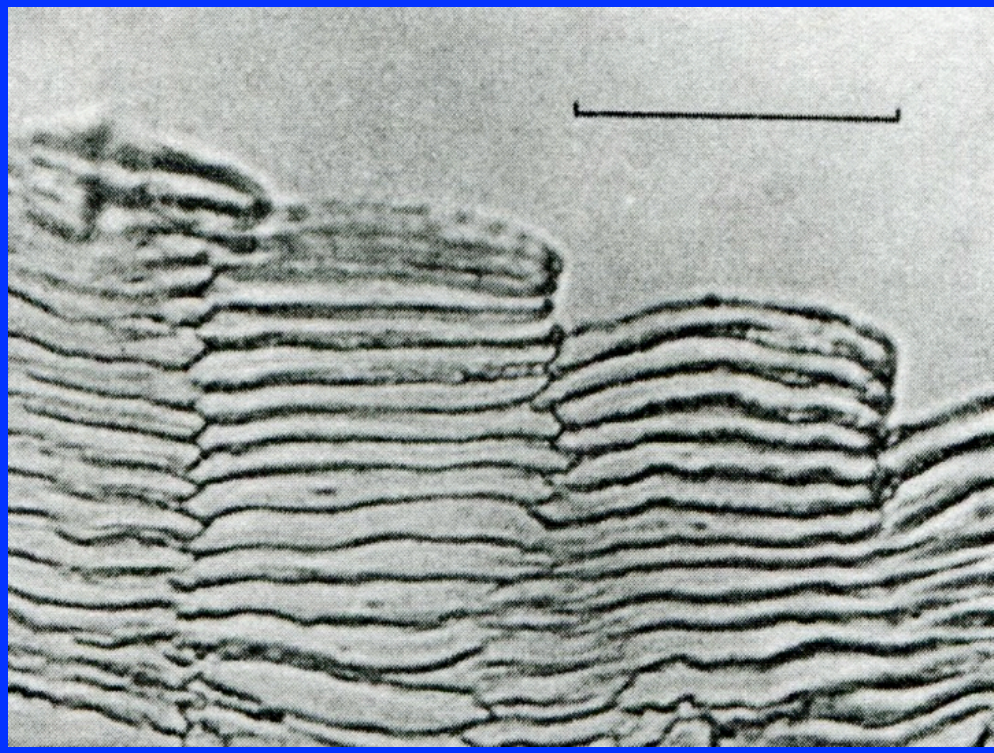



Epidermis
Dermis
Fat
Stratum corneum
Eccrine Duct
Eccrine Gland

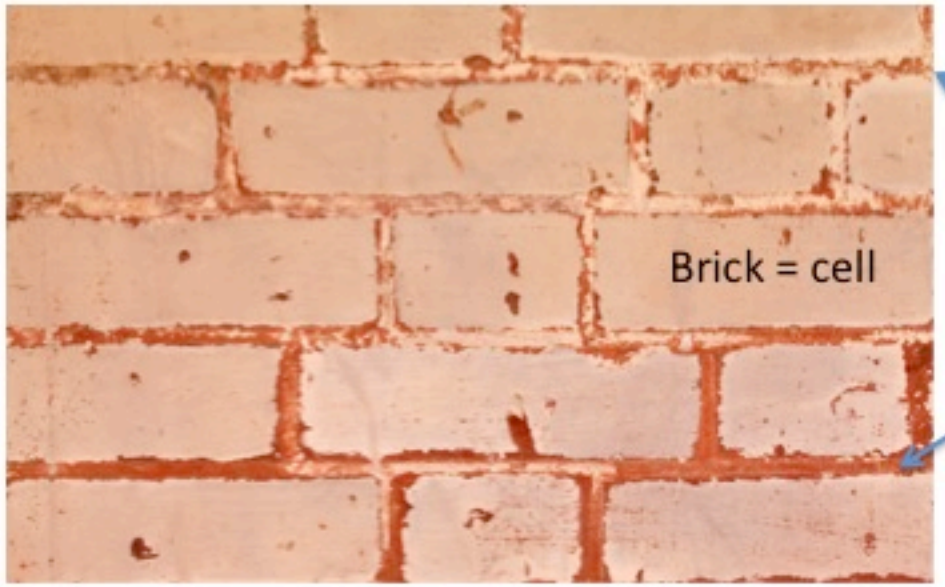

Epidermis
Dermis
Fat
Stratum
ccrine Duct
Eccrine Gland



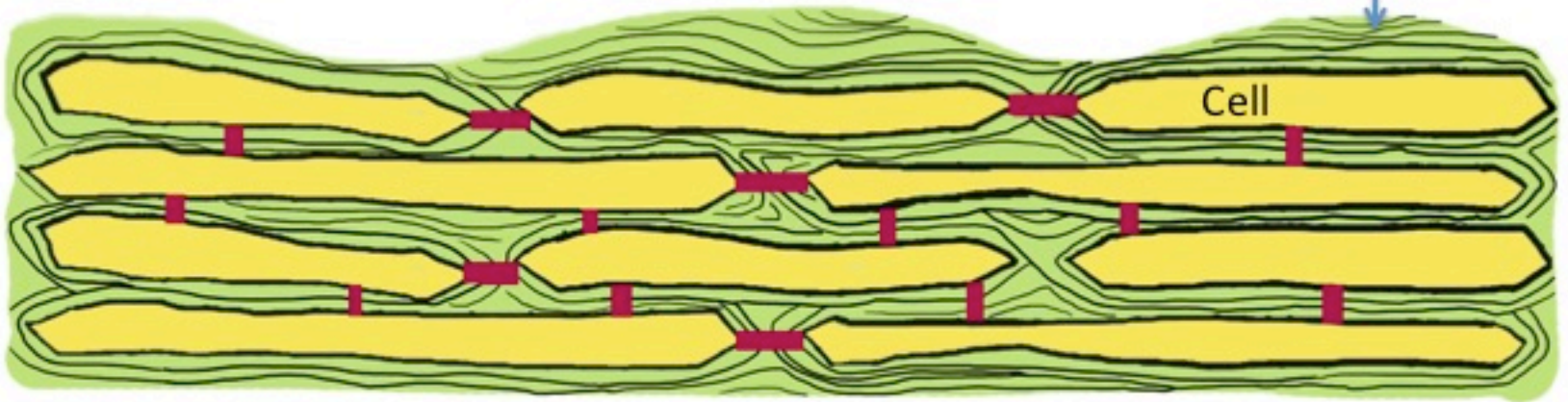
Frozen section of Stratum corneum

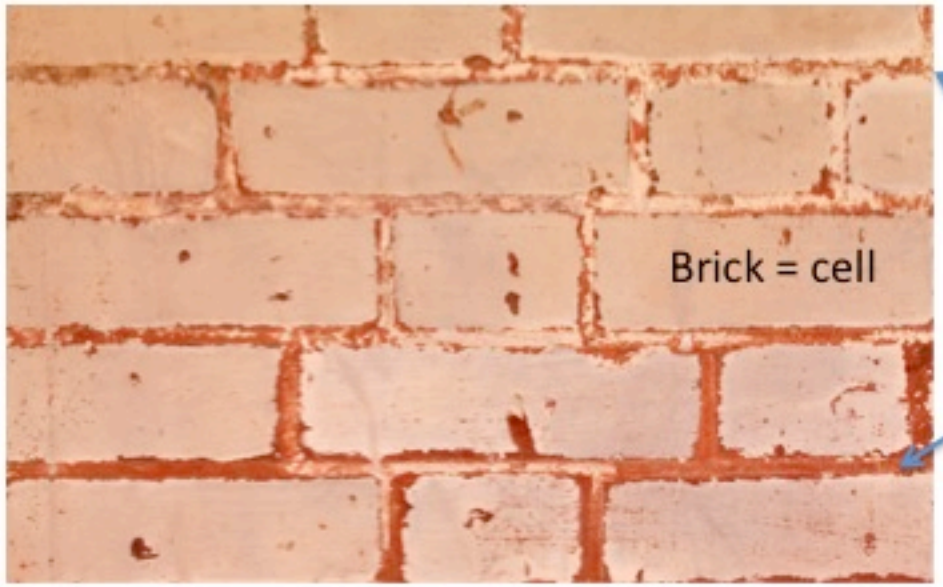


Stratum corneum = Environmental interface

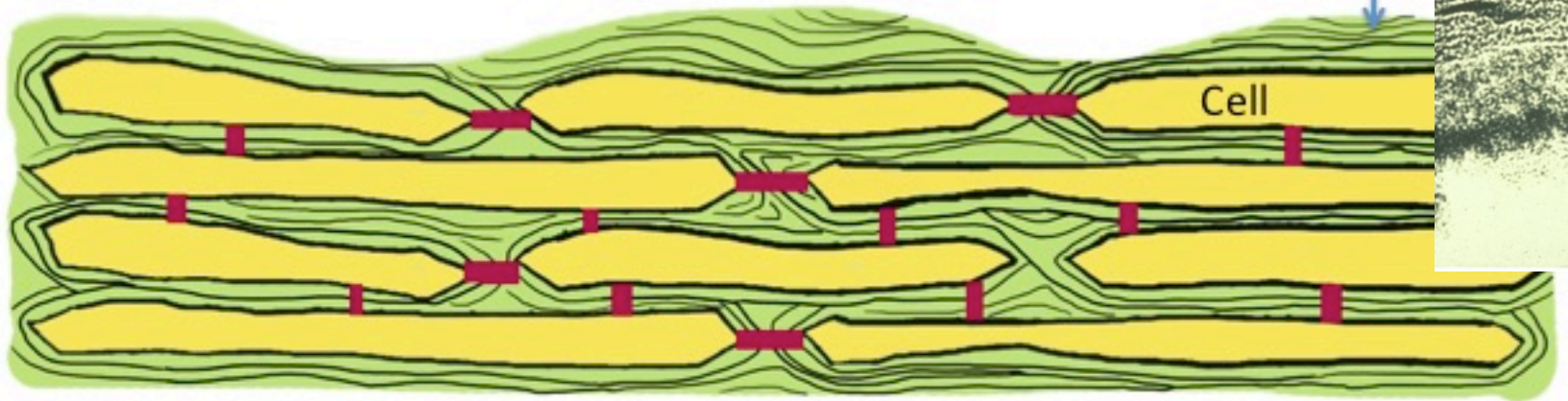


Mortar = membrane lipids

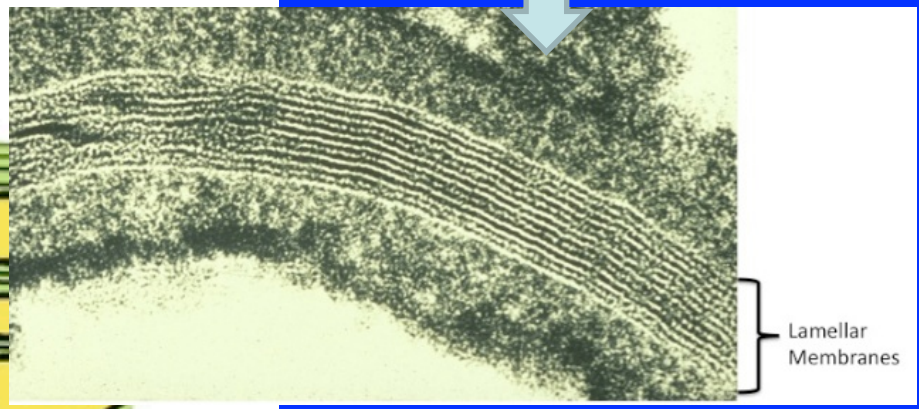




Mortar = membrane lipids

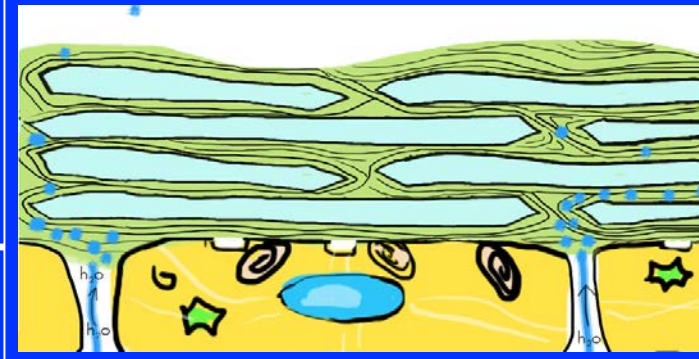


Remnants of corneocyte



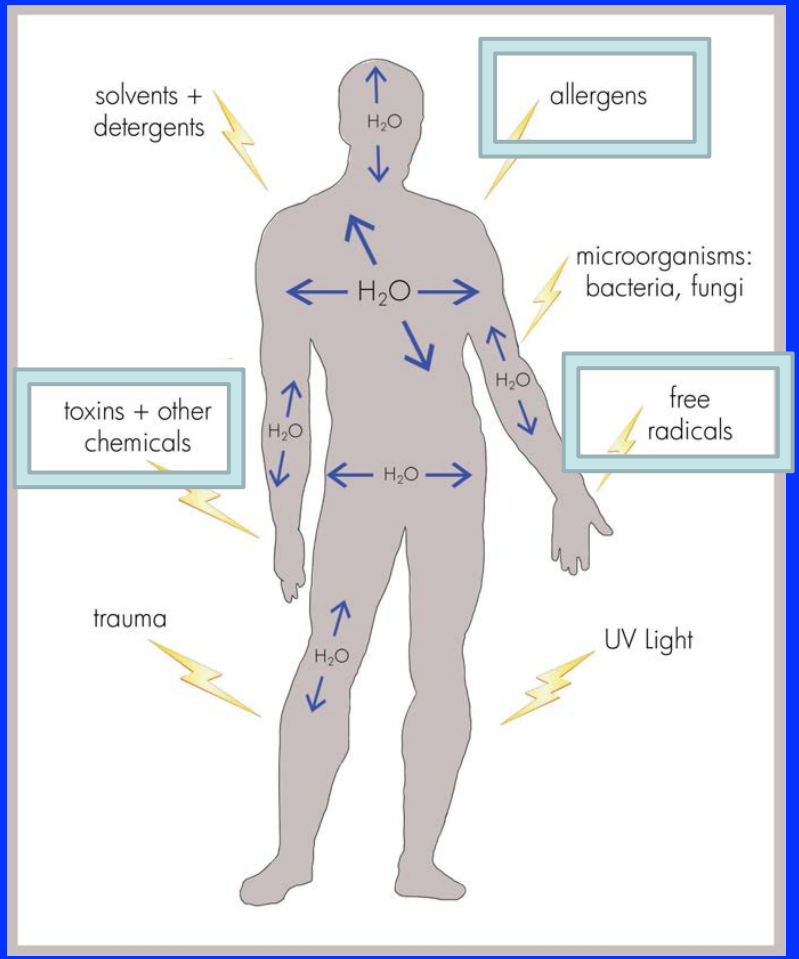
The Barrier is in the Mortar

"BRICK"	"MORTAR"	"BRICK"	
Corneocyte (hydrophilic)	Lamellar Membranes (hydrophobic)	Corneocyte (hydrophilic)	Stratum Corneum
Keratinocyte (plasma and organelle membranes) (hydrophobic)	Interstitial Fluid (hydrophilic)	Keratinocyte (plasma and organelle membranes) (hydrophobic)	Nucleated Epidermal Layers

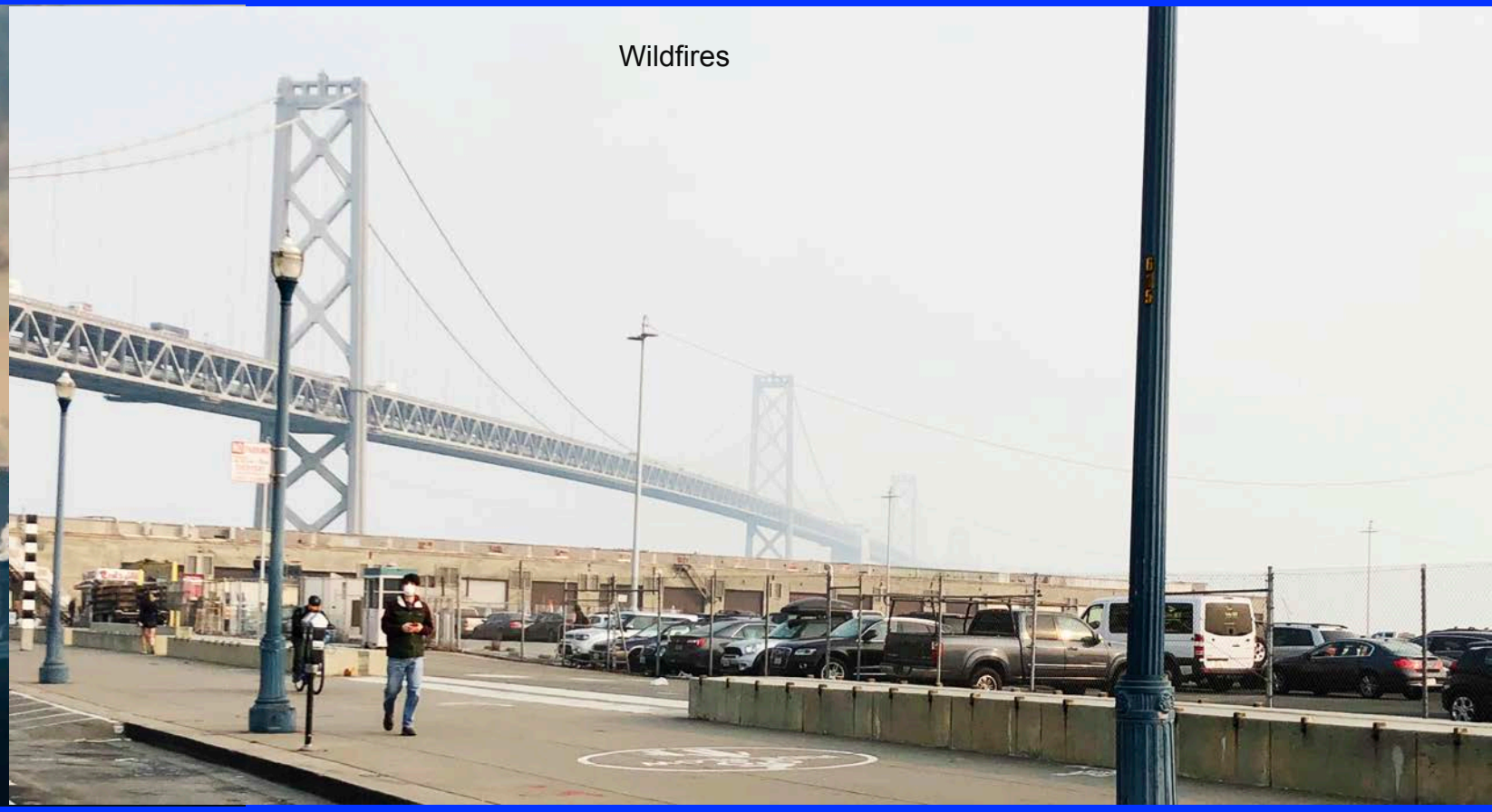


Permeability Barrier = Job # 1

- Based upon fatty (lipid) membranes
- Prevents Water Loss
- Also excludes foreign chemicals
  - Especially effective against water soluble ones
  - Less effective against fatty compounds (lipids)



Pollution: Fellow-Traveler of Climate Change



Air Pollution and Skin

- Skin is permeable to lipophilic pollutants
  - Polycyclic hydrocarbons coating particulate matter
- Nitrous oxide, ozone
- Oxidative stress
  - Ozone
  - Polycyclic hydrocarbons

Skin Effects of Air Pollution

- Skin Aging & Pigmentation
- Atopic dermatitis
  - Risk of developing
  - Flares
- Eczema in older adults
- Acne flares

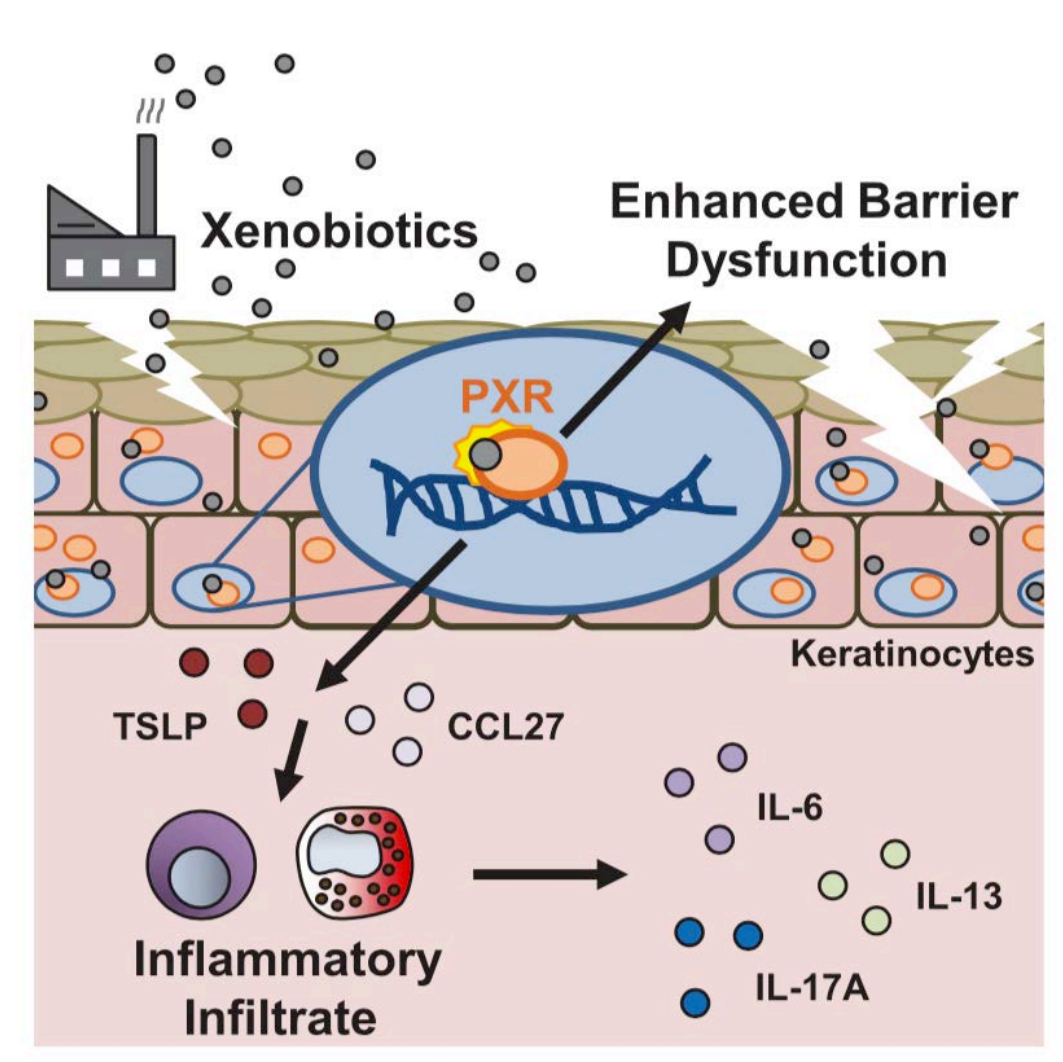
Elentner et al. JID 138:109-120, 2017
Oetjen et al JID 138:8-10, 2017
Krutmann et al. J Dermatol Sci 85:152-161, 2017
Koohgoli et al. Exper Dermatol 26:384-387, 2017

Skin Effects of Air Pollution

- Skin Aging & Pigmentation
- Atopic dermatitis
  - Risk of developing
  - Flares
- Eczema in older adults
- Acne flares

Elentner et al. JID 138:109-120, 2017
Oetjen et al JID 138:8-10, 2017
Krutmann et al. J Dermatol Sci 85:152-161, 2017
Koohgoli et al. Exper Dermatol 26:384-387, 2017

Skin Effects of Air Pollution



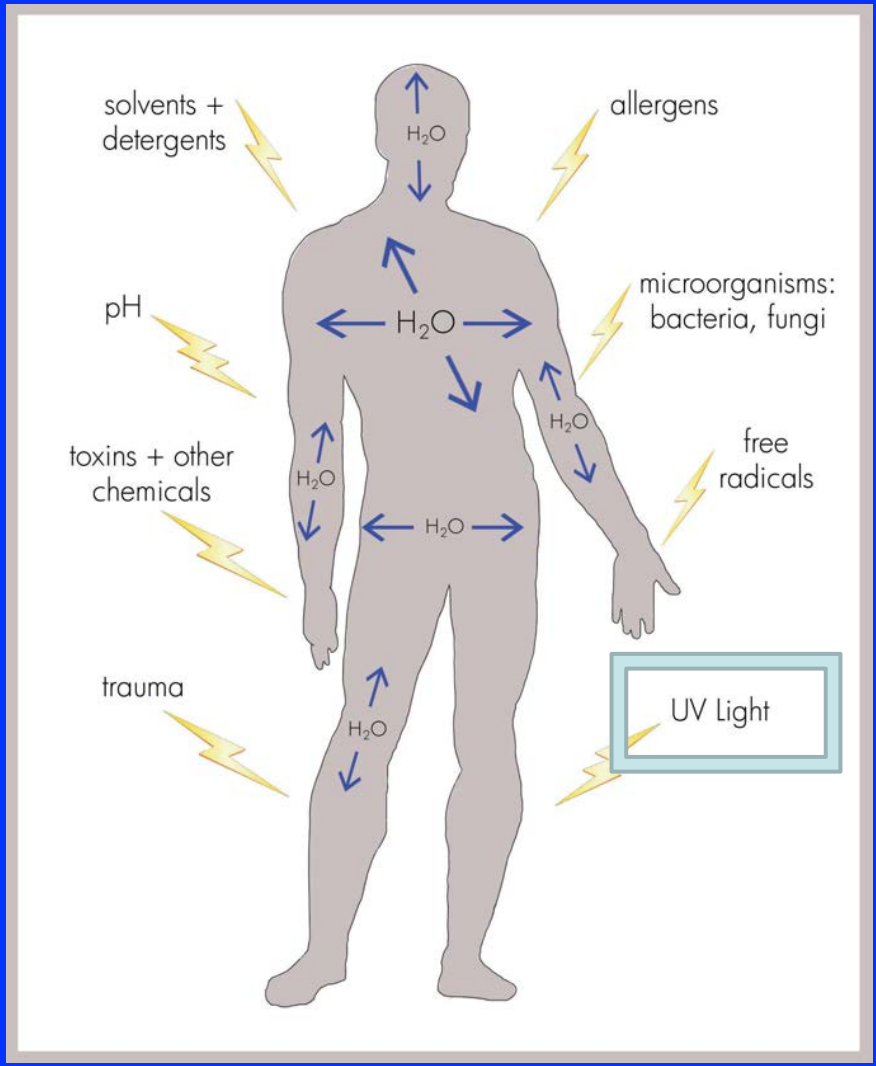
- Skin Aging & Pigmentation
- Atopic dermatitis
  - Risk of developing
  - Flares
- Eczema in older adults
- Acne flares

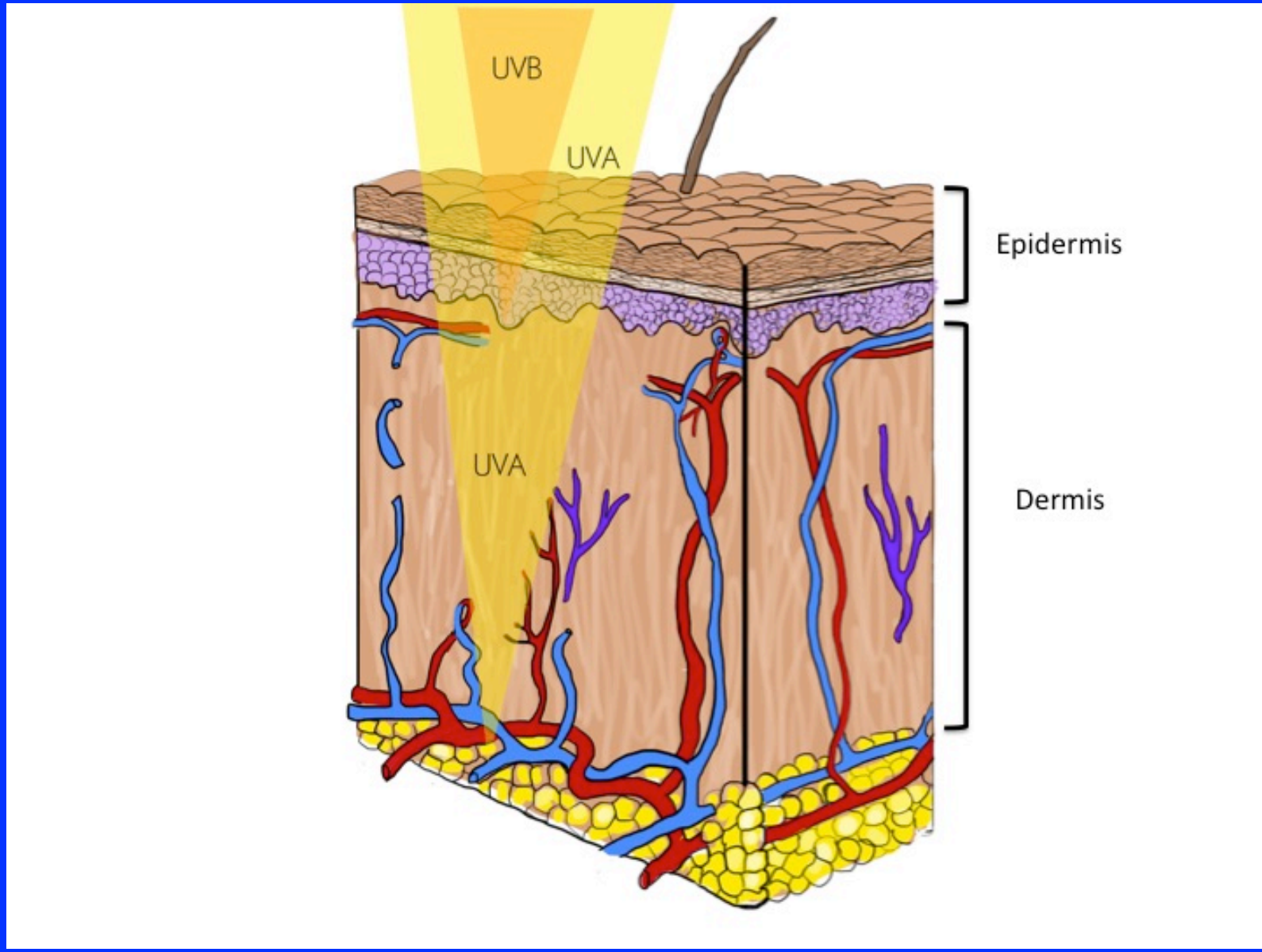
Elentner et al. JID 138:109-120, 2017
Oetjen et al JID 138:8-10, 2017
Krutmann et al. J Dermatol Sci 85:152-161, 2017
Koohgoli et al. Exper Dermatol 26:384-387, 2017

Skin Effects of Air Pollution

- Skin Aging & Pigmentation
- Atopic dermatitis
  - Risk of developing
  - Flares
- Eczema in older adults
- Acne flares

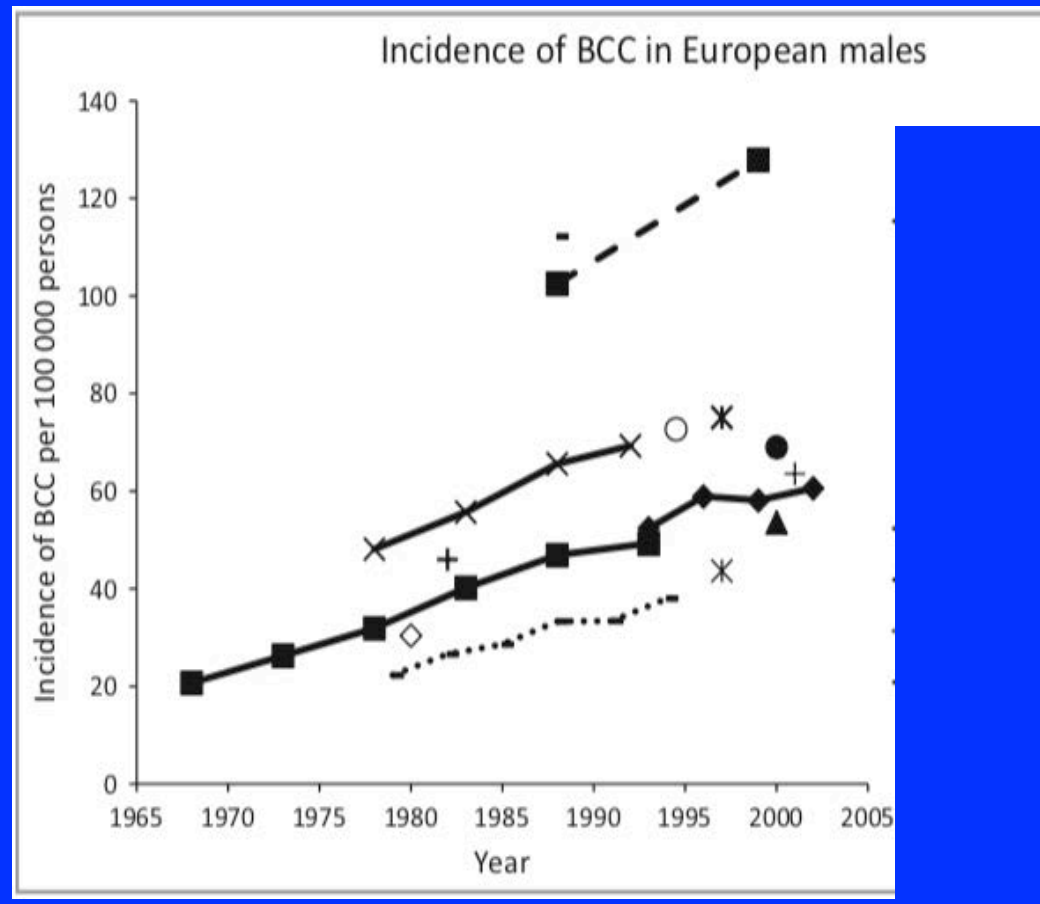
Elentner et al. JID 138:109-120, 2017
Oetjen et al JID 138:8-10, 2017
Krutmann et al. J Dermatol Sci 85:152-161, 2017
Koohgoli et al. Exper Dermatol 26:384-387, 2017


solvents + detergents
allergens
pH
microorganisms: bacteria, fungi
toxins + other chemicals
free radicals
trauma
UV Light
H_2O


UVB
UVA
UVA
Epidermis
Dermis

The Skin Cancer Epidemic

- Common skin cancers linked to sun exposure
- All increasing in incidence
  - Cumulative exposures over many years



Lomas et al. Br J Dermatol 166:1060, 2012

Squamous Cell Carcinoma

Basal Cell Carcinoma

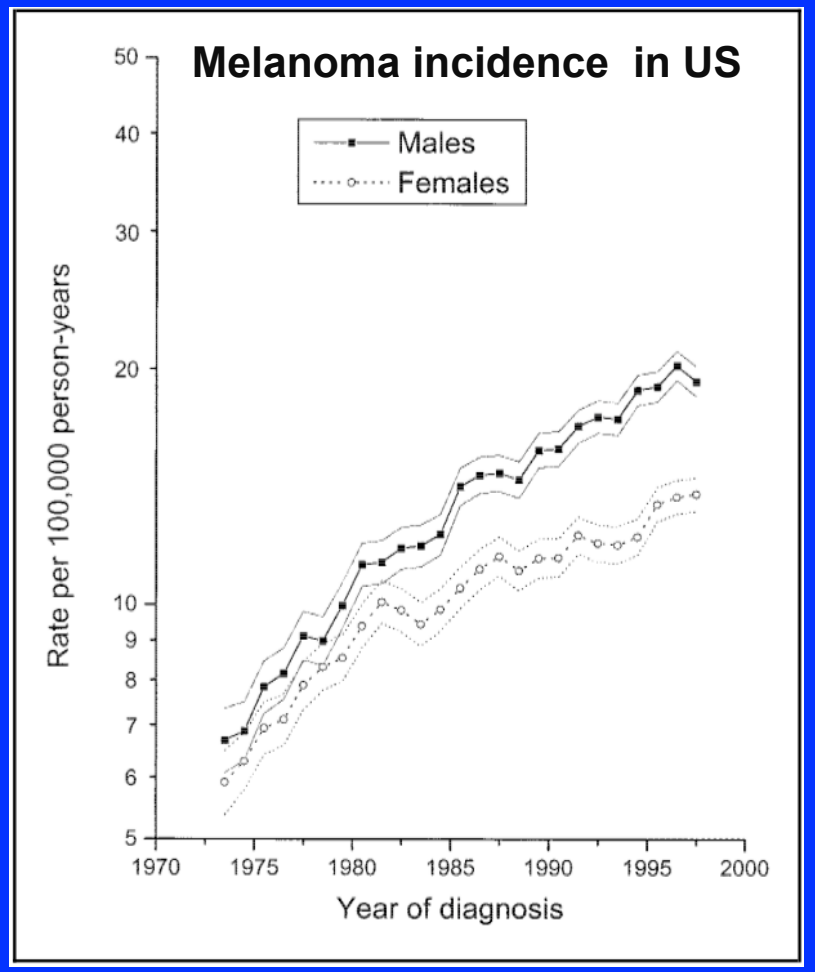
https://dermnetnz.org

The Skin Cancer Epidemic

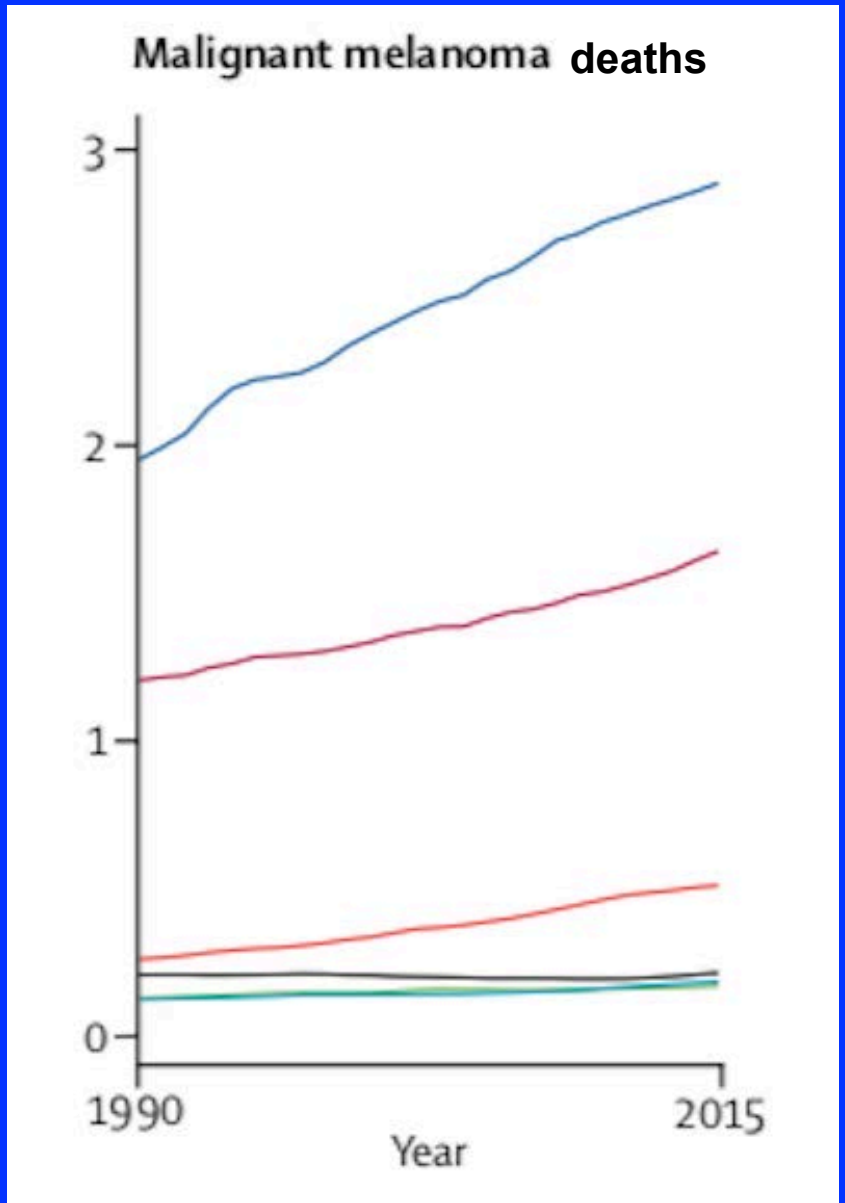
- Common skin cancers linked to sun exposure
- All increasing in incidence
  - Intermittent intense exposures
    - Malignant melanoma

https://dermnetnz.org

Melanoma Mortality in Different Regions



Jemel et al. J Natl Cancer Inst 93:678, 2001



The Lancet Countdown on Climate Change Health. 2017

Europe

Americas

Western Pacific

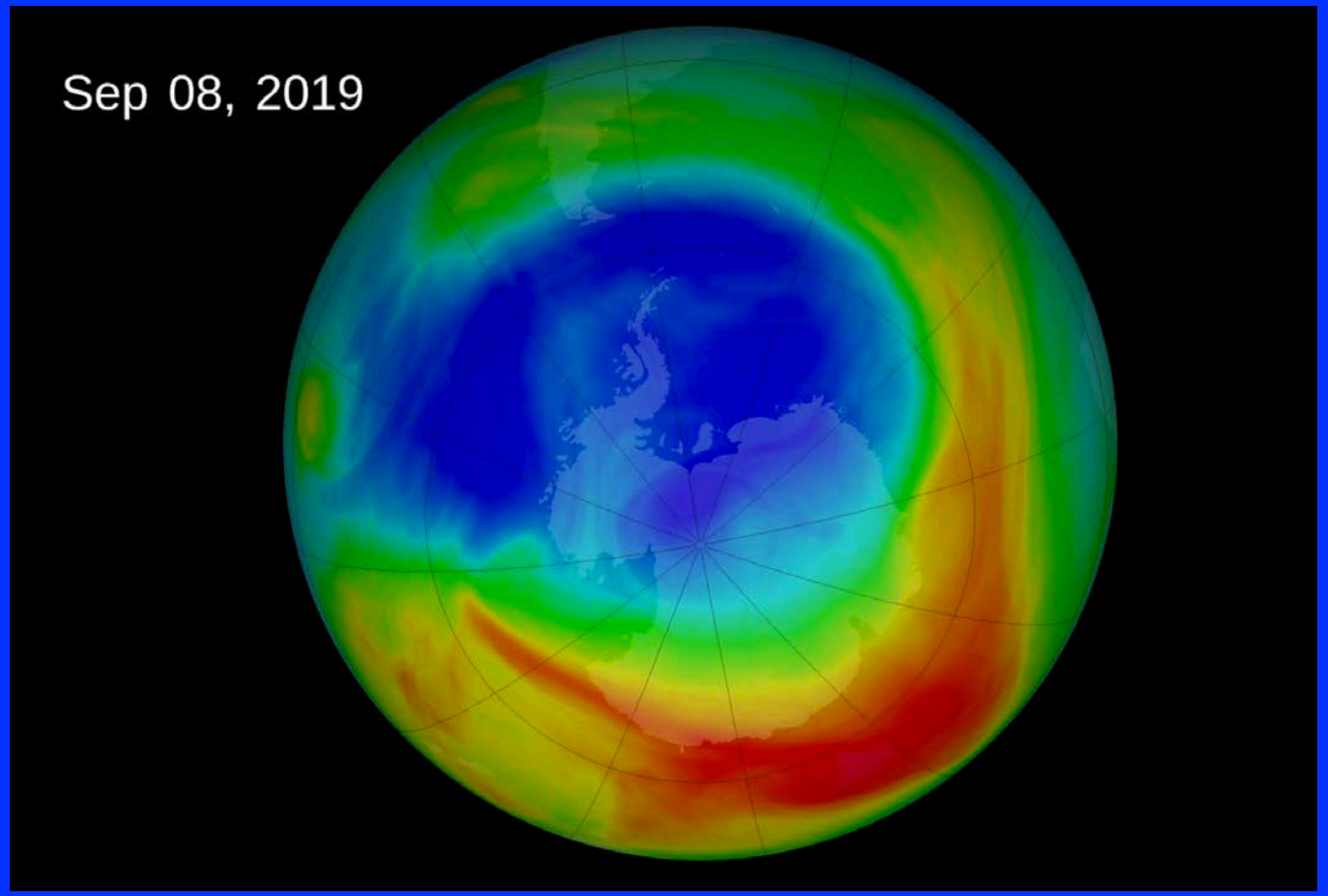
Africa & Southeast Asia

Climate Change and Skin Cancer

- Warmer temperatures
  - Behavioral effects
  - ?Potentiate UV carcinogenesis
-

Climate Change and Skin Cancer

- Warmer temperatures
  - Behavioral effects
  - ?Potentiate UV carcinogensis
- Holes in the Stratospheric ('good') ozone layer
  - Letting more UVB into atmosphere
  - Not closed until 2050



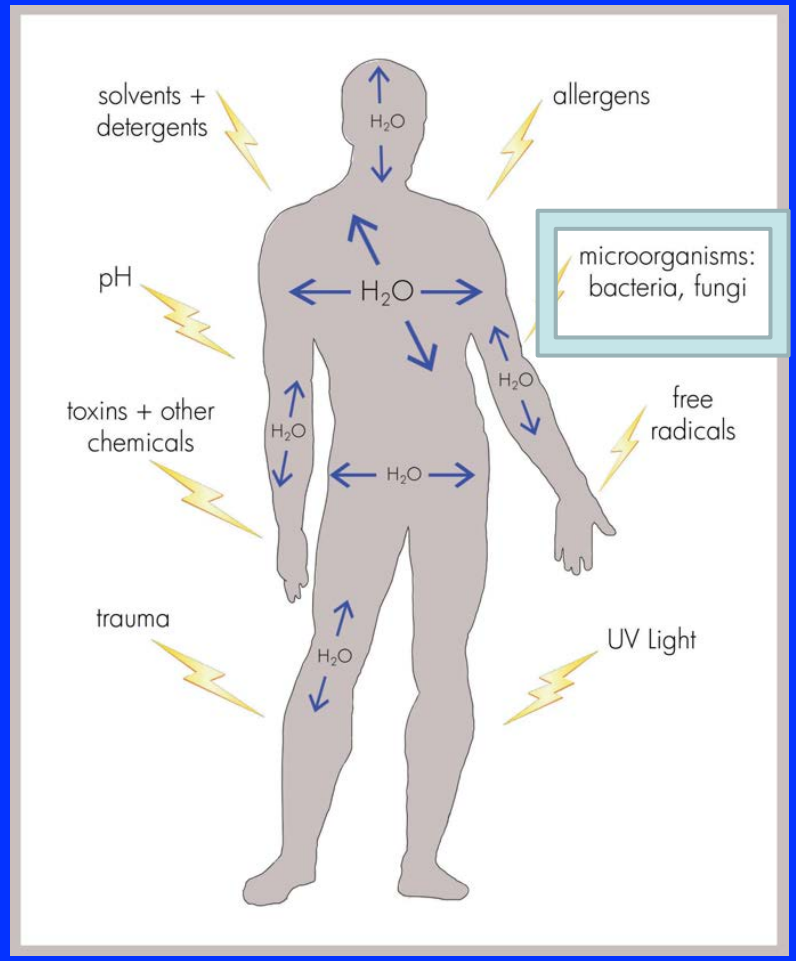
https://www.nasa.gov/feature/goddard/2019/2019-ozone-hole-is-the-smallest-on-record-since-its-discovery

Climate Change and Skin Cancer

- Warmer temperatures
  - Behavioral effects
  - ?Potentiate UV carcinogensis
- Holes in the Stratospheric ('good') ozone layer
  - Letting more UVB into atmosphere
  - Not closed until 2050
- Tropospheric ('bad') ozone
  - Secondary pollutant from heat & UV on air pollutants from fossil fuels
  - Oxidative stress potentiates carcinogenesis UV carcinogenesis

The Antimicrobial Barrier

- Co-localizes with the water barrier
- Acidic skin surface (pH 4.5-5.5)
- Antimicrobial peptides
- ‘Friendly’ microbiome



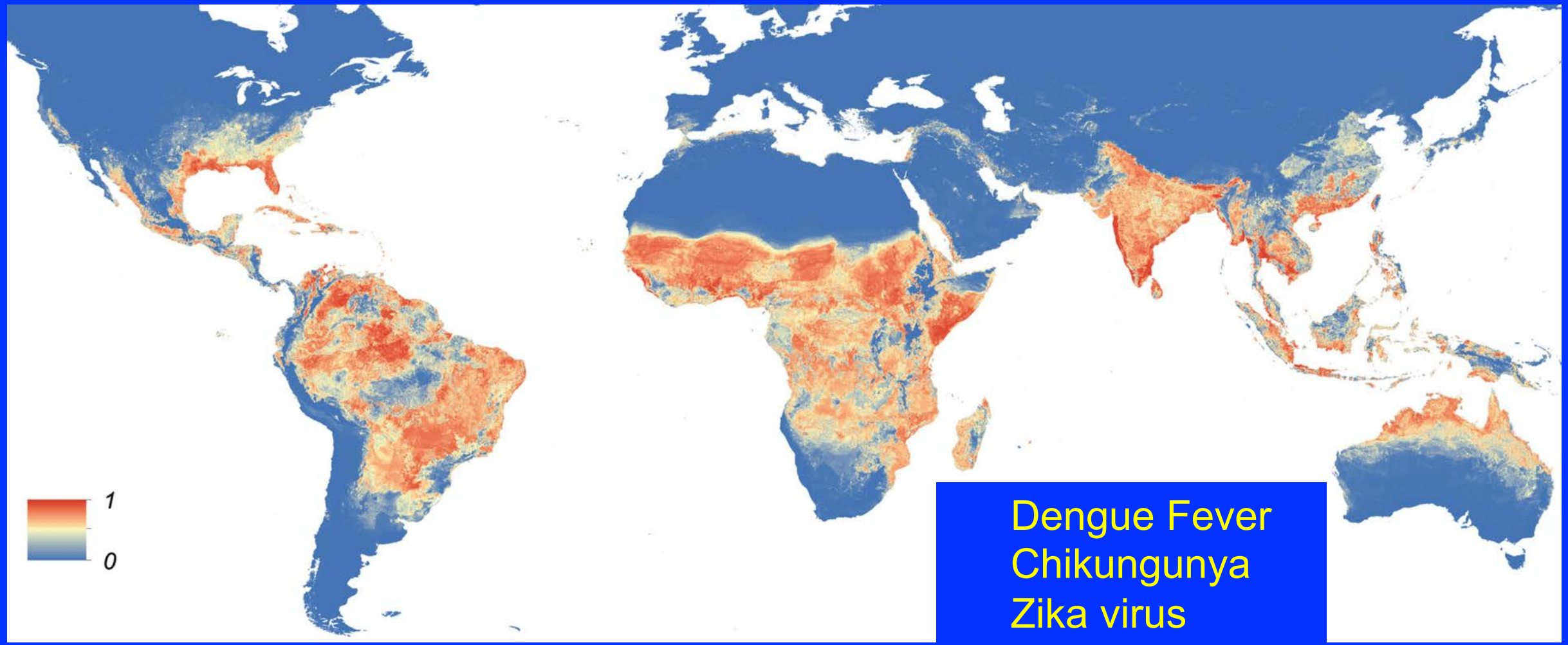
Mosquitos:
Dengue fever
Zika
Yellow Fever
Chikungunya
West Nile virus
Malaria

Sand flies:
Leishmaniasis

Ticks:
Lyme disease
Rocky Mountain Spotted Fever
Ehrlichosis
Meat allergy

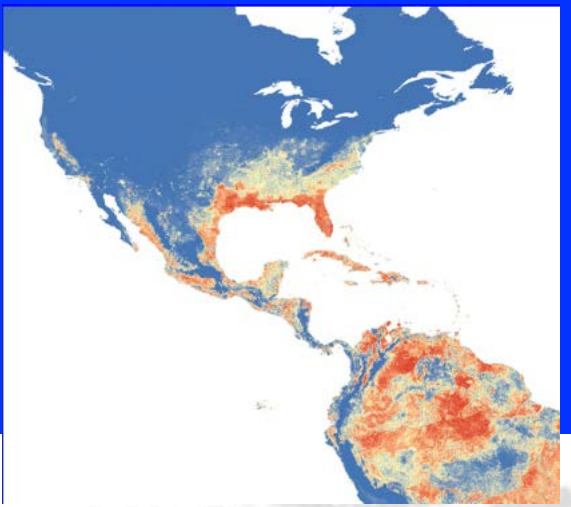
Fleas:
Typhus
Plague

Global Distribution of ***Aedes aegypti***



Dengue Fever
Chikungunya
Zika virus
Yellow Fever

https://www.dni.gov/files/documents/Newsroom/Testimonies/2018-ATA---Unclassified-SSCI.pdf



Aedes aegypti distribution 2018

Aedes Habitat Projection under Worst Case Scenario

Now

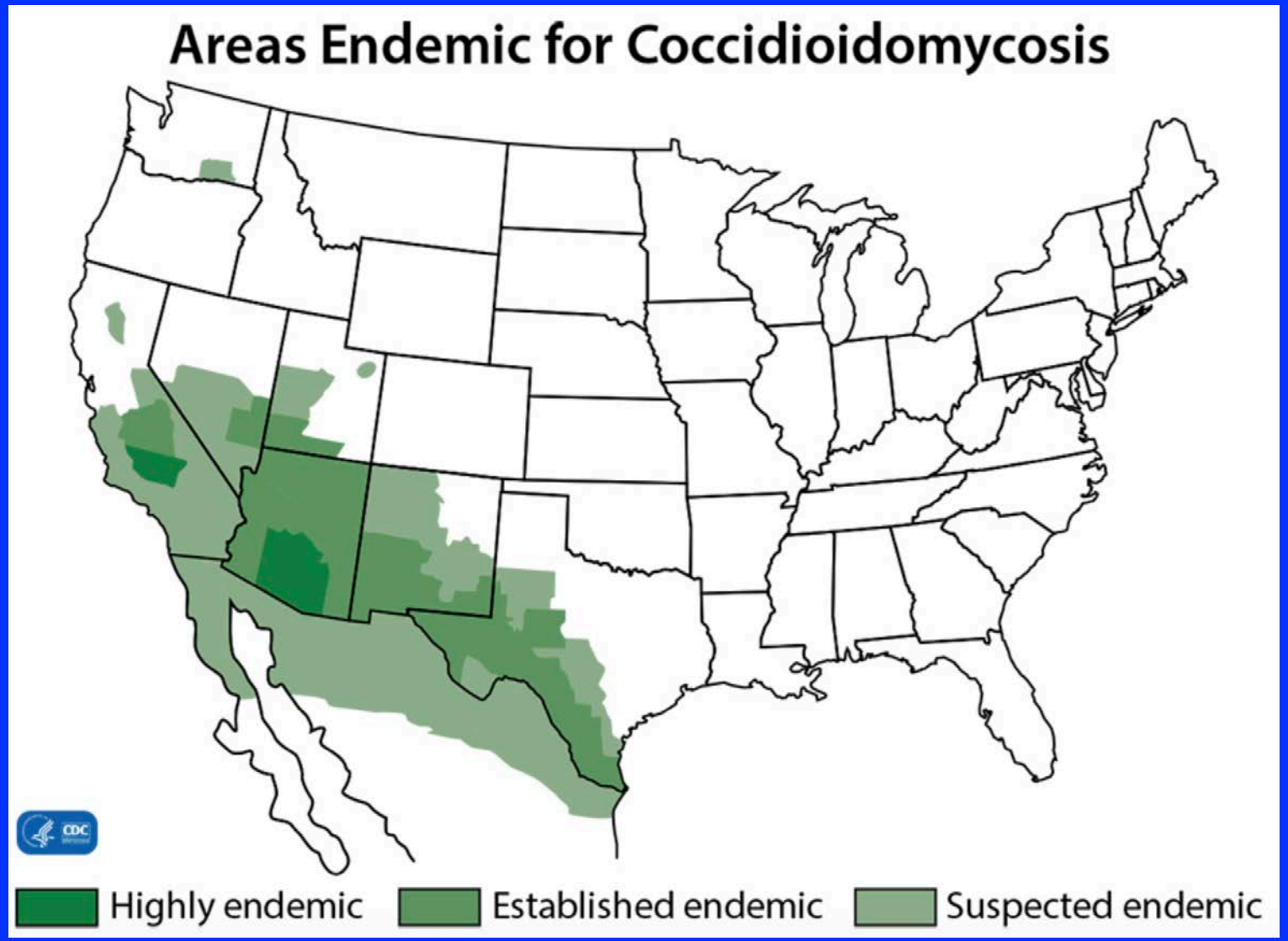
2050

2080

1 2 3 4 5 6 7 8 9 10 11 12

Number of months per year when disease transmission by *Aedes aegypti* mosquito is possible

Valley Fever



http://www.cdc.gov/fungal/diseases/coccidioidomycosis/causes.html

Injuries during Extreme Weather Events

https://www.npr.org/sections/thetwo-way/2017/08/28/546735184/what-were-hearing-in-texas-residents-discuss-harveys-floods Photo by David J Philip/ AP

DOI: https://doi.org/10.1016/j.jdcr.2020.04.011

Skin Signs of Infectious Disease: Covid 19

‘Frostbite’ toes and other peculiar rashes may be signs of hidden coronavirus infection, especially in the young

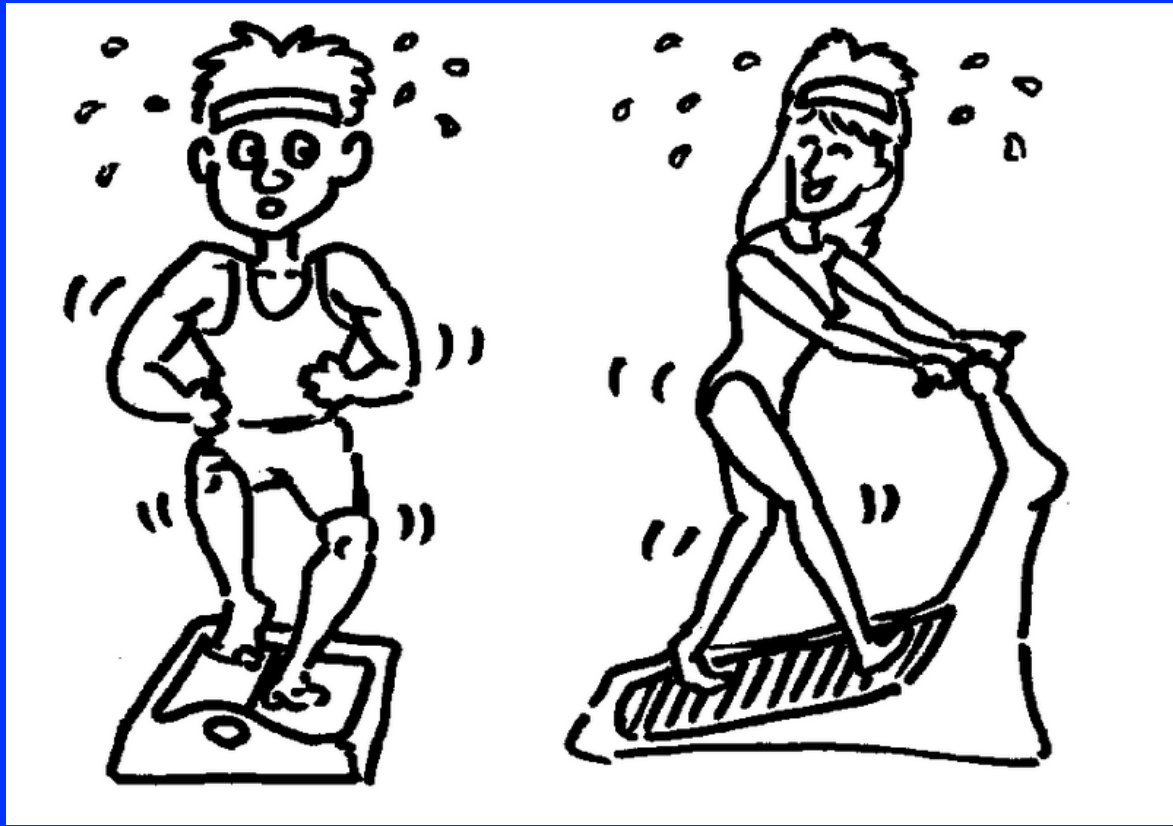
The cases tend to be mild and resolve on their own. But doctors recommend those with symptoms consider getting tested for the virus and self-isolate.

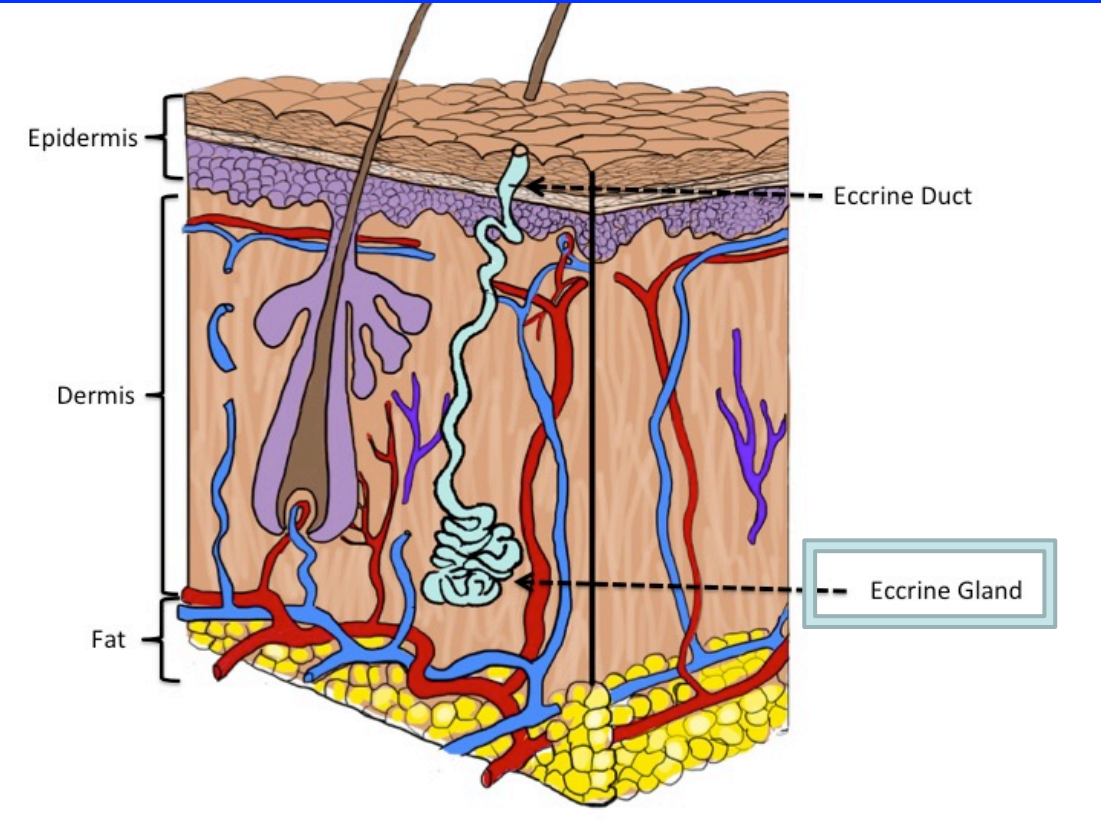
https://www.washingtonpost.com/health/2020/04/29

Kolivras et al 2020

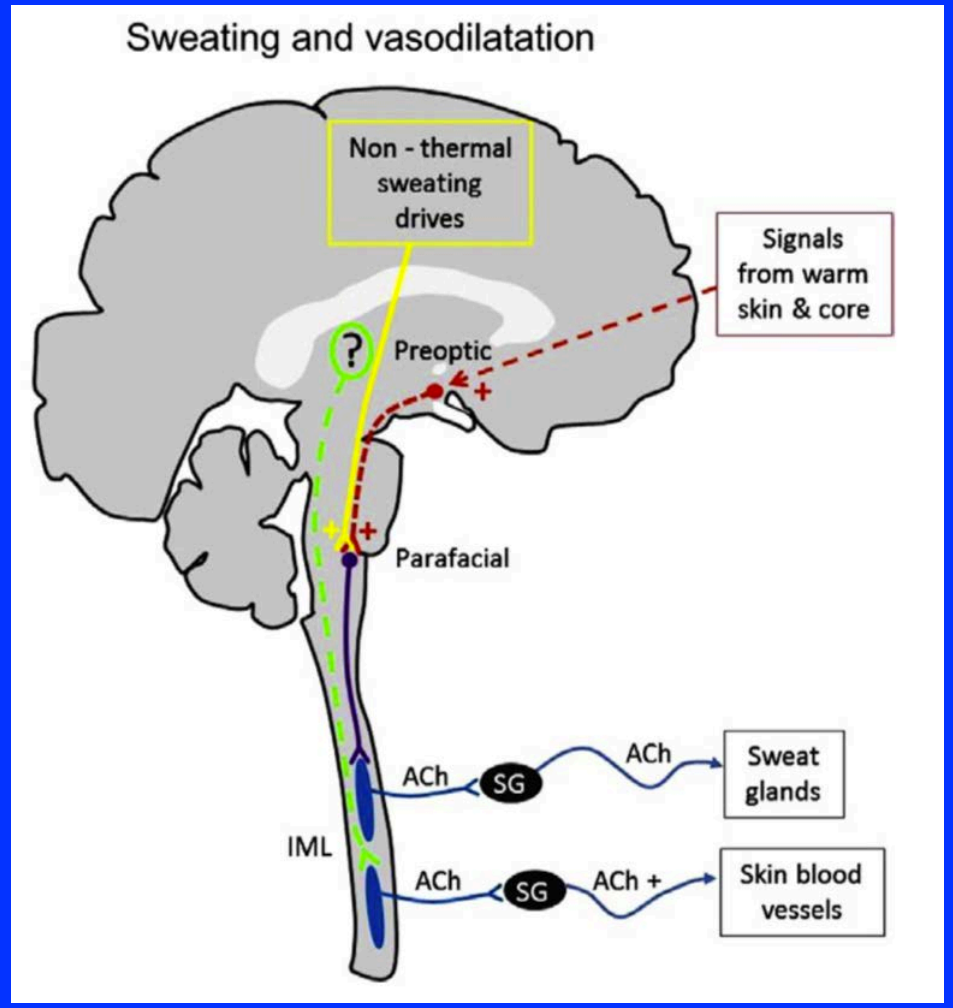
DOI: https://doi.org/10.1016/j.jdcr.2020.04.011

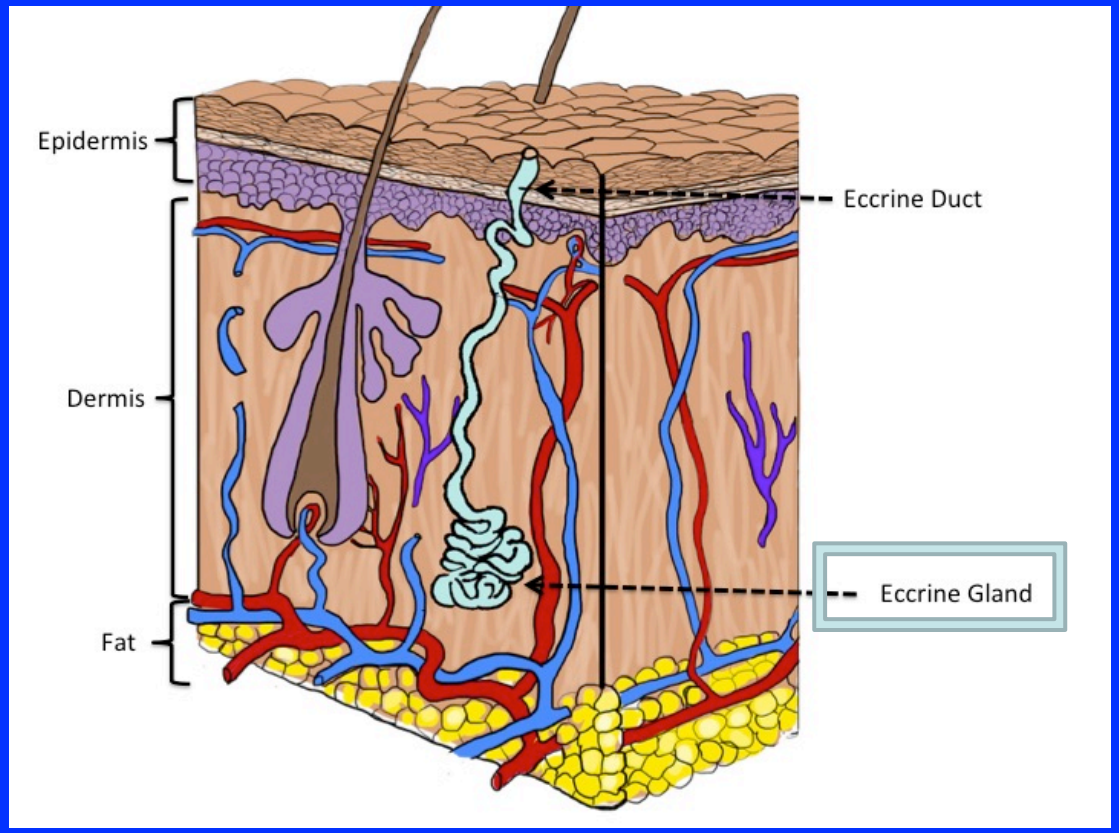
To Be Human Is To Sweat





To Be Human Is To Sweat





McAllen and McKinley. Handbook of Clinical Neurology 2018

Not Everyone Sweats Equally

- Newborns < Children < Adults
- Women < Men
- Aged < Young Adults
  - Decline starts at age 40!
- < Certain diseases
  - Diabetes, neurological, cardiovascular, skin
- < Certain medications
  - anticholinergics

Classes of Drugs with Anticholinergic Effects

- Anticholingerics
  - e.g., Scopolamine, atropine
- Antihistamines
  - e.g., diphenhydramine (Benadryl®); hydroxyzine (Atarax®)
- Antipsychotics
  - e.g., chlorpromazine (Thorazine®)
- Antiparkinsonians
  - E.g., benztopine (Cogentin®)
- Bladder antispasmodics
  - e.g., oxybutynin (Oxytrol®)
- Muscle relaxants
  - E.g., cyclobenzaprine (Flexeril®)
- Antiemetics
  - e.g., meclizine
- Antidepressants
  - e.g., imipramine (Tofranil®)

Skin In Climate Change

- Attacks on the Skin's Barrier
  - Pollutants
  - UV light
  - Biting insects
- Sweat capacity and Vulnerability to Heat Stroke

Thank You!

- Meeting organizers: Katherine Gundling, M.D. and Robin Cooper, M.D,

Thank You!

- Tom Newman M.D., Robert Gould M.D., Bay Area PSR's Environmental Committee,
- Misha Rosenbach M.D. and the AAD's ERG on CC & EI
- Mona Sarfaty, M.D, and the Medical Society Consortium
- Sarah Coates, M.D.

PSR
San Francisco-
Bay Area Chapter

AAD
AMERICAN ACADEMY of DERMATOLOGY | ASSOCIATION
Excellence in Dermatologic Surgery™

The Medical Society Consortium
ON CLIMATE & HEALTH

Thank You!

- My Family

- My Husband, Peter M. Elias, M.D.

:

- My son:John (‘Jack’) Williams, PhD.

Thank You!

- My Family
- My Grandchildren

Thank You?

Thank You!

Role of Skin in Temperature Regulation

- Cutaneous Vasodilation
  - Heat loss through conduction, convection
  - Only effective if external T < internal
- Eccrine sweat
  - Unique human adaptation
  - Most important form of heat dissipation in warm/hot environment
    - Cooling as water evaporates from skin surface
    - 0.59Kcal/ml
    - Efficiency dependent upon humidity
  - Trade-off: dehydration