### Review of Retinoid Biology: Part 2

**Mariana Phillips, MD. (Updated July 2015*)**

#### Photobiology

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<th>Spectrum</th>
<th>Wavelengths</th>
<th>Description</th>
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| **UVA**  | UVA1: 340-400 nm  
          | UVA2: 315-340 nm  | Responsible for photoaging; >95% of sun’s UV radiation reaching Earth’s surface  
          | Penetrates glass  | Predominately UVA sunblocks: anthranilates, oxybenzone, avobenzone |
| **UVB**  | UVB: 290-315 nm  | Most important in photocarcinogenesis; wavelengths most responsible for sunburn  
          | Vitamin D synthesis: 7-dehydrocholesterol pre-vitamin D3  | Predominately UVB sunblocks: PABA, cinnamates, salicylates, Padimate O |
| **UVC**  | UVC: 200-250 nm  | Absorbed by ozone in the atmosphere |

#### Acute tanning

*Immediate pigment darkening* due to oxidation and redistribution of existing melanin  
Most prominent with UVA

#### Delayed tanning

Peaks 3 days after light exposure and may last 10 days, primarily due to UVB  
Increased number and size of melanocytes, increased tyrosinase activity (melanin synthesis), and increased melanocyte dendrites

#### Sunburn

UVB

**Thymidine dimer photoproducts**

- Occurs in DNA following excitation with short wave UVB  
- “UV signature mutations”  
- Results in transition mutations during DNA transcription  
- Occurs due to covalent linkage between two pyrimidines  
- Most common: T-T > C-T > T-C > C-C

**Pyrimidine-pyrimidone photoproducts**

- Same as above with thymidine dimers  
- Most common: T-C > C-C and T-T

**8-hydroxyguanosine photoproduct**

- Characteristic DNA damage generated by UVA  
- Generates G:C to T:A transversion mutations during transcription

#### Sunless Tanning

Dihydroxyacetone binds stratum corneum and produces tanned appearance  
Provides SPF 2-3

#### Sunscreens

**SPF (Sun Protection Factor)**

- Measures protection in the UVB spectrum, max labeling allowed by FDA is 50+

**Water resistant**

- Maintains SPF while swimming/sweating: 40 min and 80 min labeling permitted only

**Waterproof/Sweatproof**

- No longer permitted labeling per the FDA

**Timing and amount**

- Apply sunscreen 20 minutes before sun exposure  
- 1 oz of sunscreen to cover entire body (2 mg/cm²)

**Physical (inorganic) sunscreens**

- Titanium dioxide (Ti) and Zinc oxide (Zn)  
- Reflects sunlight  
- Low incidence of contact sensitivity  
- UVA and UVB protection (Zn broader than Ti)

**Oxybenzone (AKA: benzophenone)**

- Broad spectrum UVA & UVB, photo-stabilizer in Helioplex (stabilizes Avobenzone)  
- #1 sunscreen used, but controversy over hormonal and photoallergenic effects  
- Most common cause of sunscreen allergy or photoallergy

**Avobenzone**

- Trade name: Parsol 1789  
- UVA protection; derivative of dibenzoylmethane, in Helioplex (Avobenzone + Oxybenzone), Photo-stability unreliable when combined with cinnamates

**Cinnamates**

- Trade name: Parsol MCX  
- UVB protection  
- Cross-reacts with Balsam of Peru  
- Frequent cause of allergic reactions

**Octocrylene**

- Photo-stabilizer

**Ecamsule and Drometrizole trisiloxane**

- Trade name: Mexoryl  
- UVA–UVB absorber (290-390 nm)  
- Photo-stabilizer

**Cross reactivity with PABA**

- Sulfur drugs, Benzocaine (ester anesthetic), Paraphenylenediamine, Azos/Azine dyes

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## Cosmeceuticals

| Vitamin C | L-ascorbic acid is the predominant antioxidant in the skin  
| --- | --- |
|  | Essential for collagen biosynthesis, a co-factor for collagen transcription  
|  | Increases collagen I and III mRNAs  
|  | Increases tissue inhibitors of matrix metalloproteinases (MMPs)  
|  | Reduces solar elastosis  
|  | Inhibits tyrosinase, thus decreasing pigment synthesis  
|  | Improves epidermal barrier function by stimulating ceramide production  

| Vitamin E (tocopherol) | Body’s major lipid phase antioxidant  
| --- | --- |
|  | Protects against cytotoxic effects of UVB  
|  | Major function is to prevent lipid peroxidation  
|  | Inhibits melanogenesis and has activity against tyrosinase  
|  | Inhibits thymidine dimer formation  
|  | Topical use may lead to allergic contact dermatitis (#2 allergen in sunscreens)  

| Niacinamide (nicotinamide) | Important in energy related cellular metabolic functions  
| --- | --- |
|  | Increases synthesis of collagen, filaggrin, and keratin  
|  | Thins the stratum corneum  
|  | Increases collagen I fibers in the dermis  
|  | Increases inhibitors of tissue MMPs  
|  | Reduces solar elastosis  
|  | Inhibits tyrosinase, thus decreasing pigment synthesis  
|  | Improves epidermal barrier function by stimulating ceramide production  

| Retinoids | Thickens the nucleated epidermis, promotes differentiation, increased keratohyaline granules, Odland body secretion, increased filaggrin  
| --- | --- |
|  | Thickens the stratum corneum  
|  | Increases collagen I fibers in the dermis  
|  | Increases inhibitors of tissue MMPs  
|  | Increases production of hyaluronic acid and fibronectin  

| Hydroxy-acids | Keratolytic  
| --- | --- |
|  | Increases type I procollagen mRNA  
|  | Stimulates TGF-β expression due to acidic pH  

| Ferulic acid (4-N-furfuryladenine) | AKA: kinetin  
| --- | --- |
|  | Plant growth factor  
|  | Acts as an antioxidant, retards aging of fibroblasts in culture  

| Soy | Most plentiful isoflavones in soy: genistein, daidzein  
| --- | --- |
|  | May have collagen stimulating effects  
|  | Reduces pigmentation by suppression of melanosome transfer to keratinocytes  

| Alpha-lipoic acid (ALA) AKA: ubiquinone-10, serves as a coenzyme for energy production within cells  
| --- | --- |
|  | Reduces expression of UVA induced MMPs  
|  | Strong intracellular free radical scavenging abilities  

| Coenzyme Q10 | Potent lipid and water soluble antioxidant  
| --- | --- |
|  | Acts as a coenzyme for energy production within cells  
|  | Reduces expression of UVA induced MMPs  

| Copper peptides | Known cofactors in antioxidant reactions  
| --- | --- |
|  | Used to promote healing in diabetic foot ulcers, surgical wounds, and post-follicular unit hair transplants  
|  | Stimulates glycosaminoglycan synthesis  

| Camellia sinensis (green tea) | Polyphenols (antioxidants) that remove reactive oxygen species (created by UVR)  
| --- | --- |

| Resveratrol (grapes, nuts) | Antioxidant, reduces UVB-induced edema  
| --- | --- |
| Slybyum Marianum (milk thistles) | Flavonoid, antioxidant  

| Curcuma longa (turmeric) | Anti-inflammatory, antioxidant  

## References:


*Reviewed and updated July 2015 by: Alina Goldenberg, MD, Elise Herro, MD, Emily deGolian, MD, and Sharon Jacob, MD.*