

The Chemistry of Haircolor

John Halal

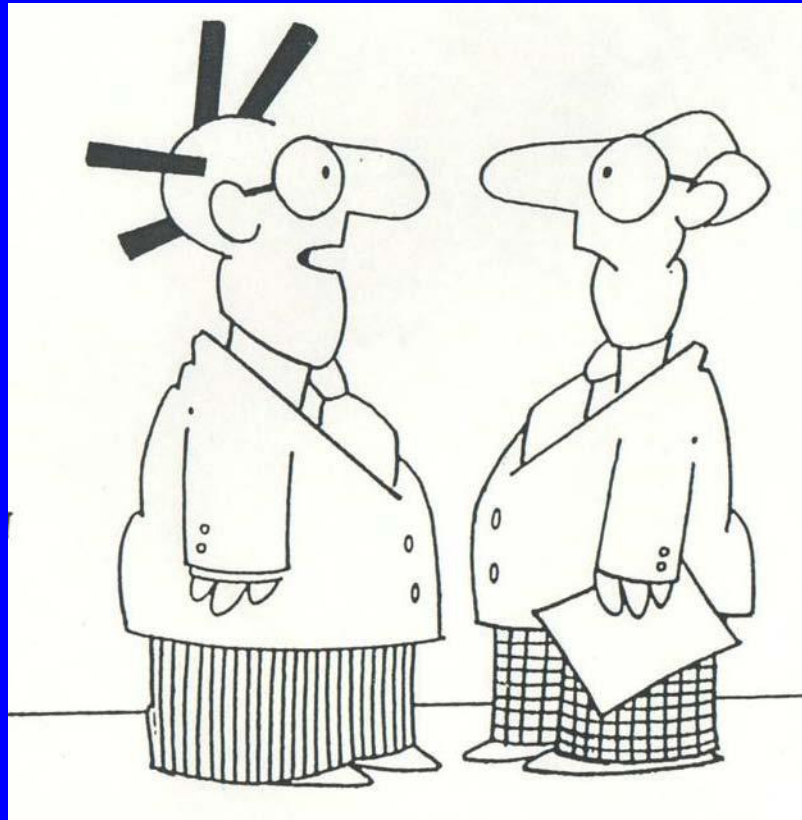
john@chemistrysimplified.com

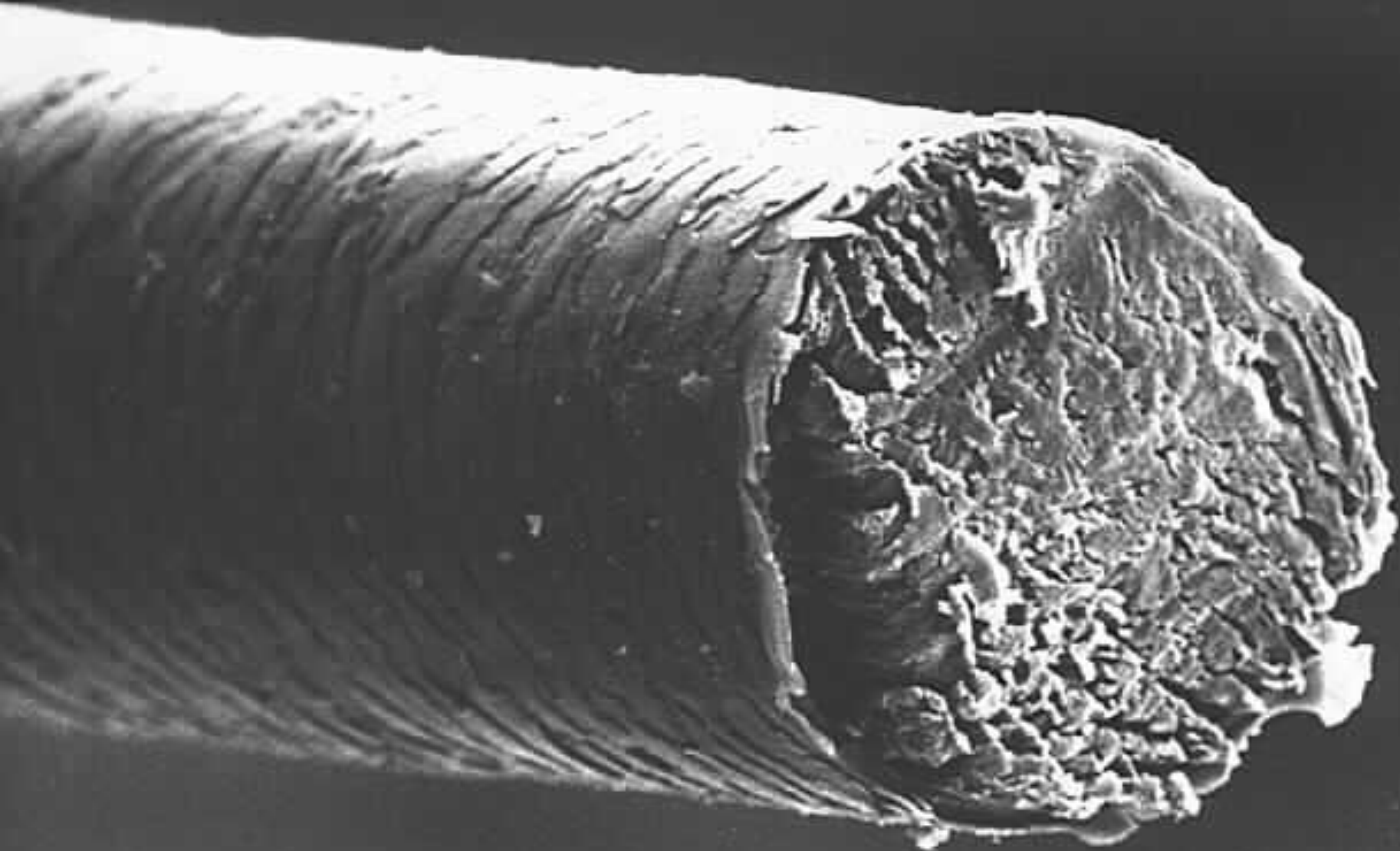
www.chemistrysimplified.com

317.506.3310



I don't have much hair left, but my special shampoo fortifies each strand and makes the remaining hair look thicker and fuller.





2729

8KV

X750

10µm

WD22

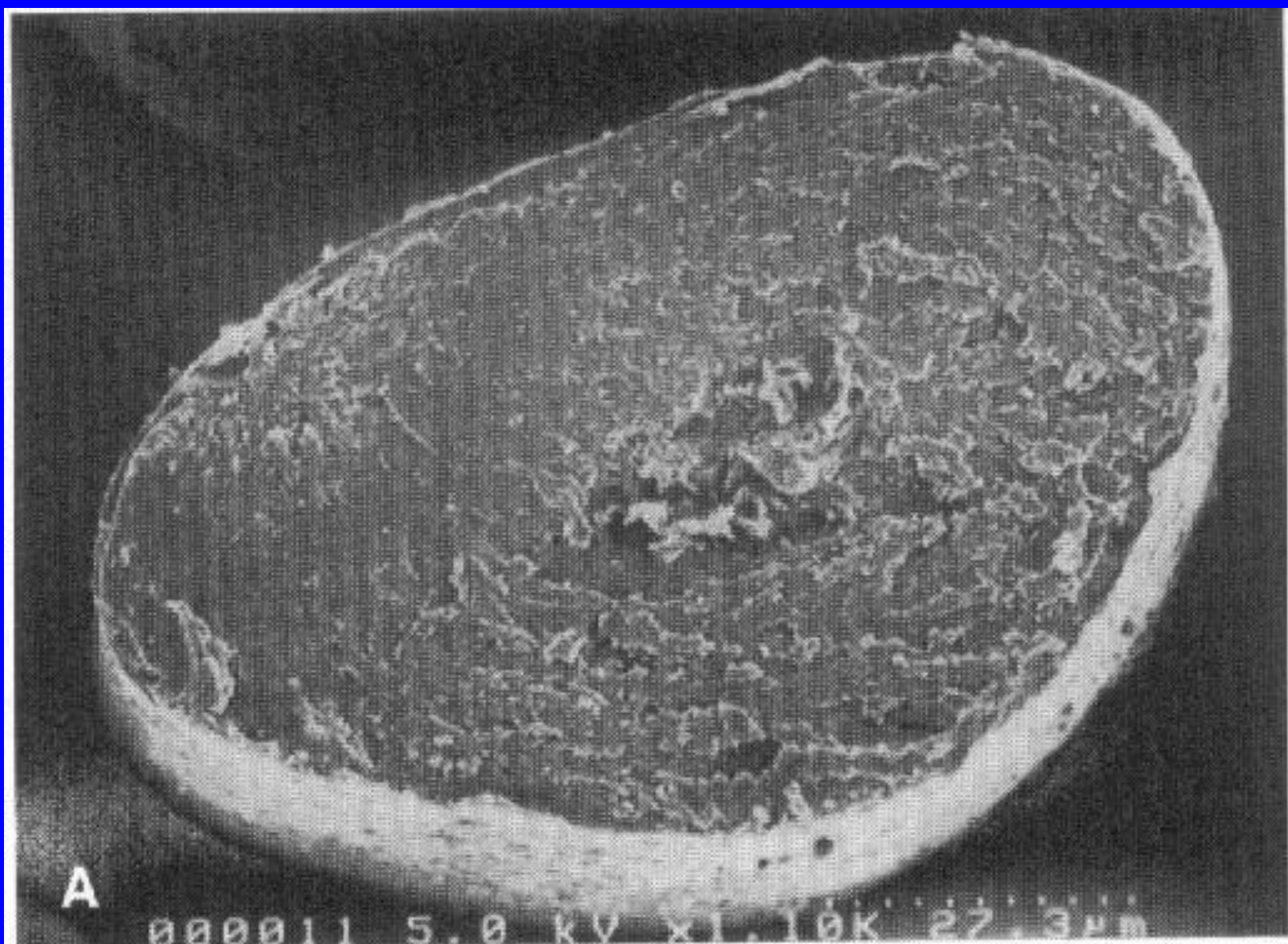


Figure 4. A. Extension to break when wet generally
S. Buetsch TRI Princeton B. Extension to break wh



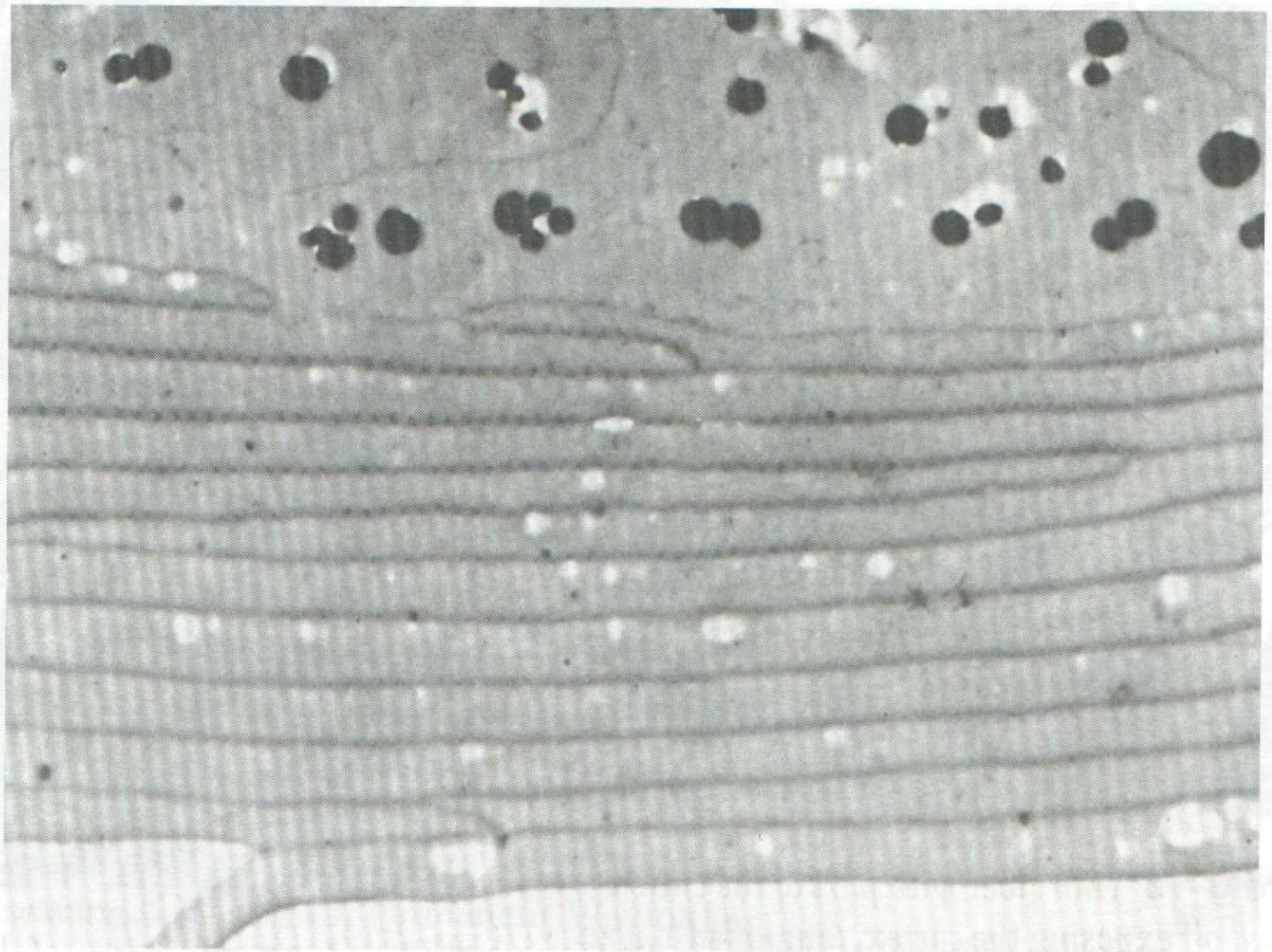


Figure 6-16 A photo of cuticle scales around the cortex, magnified 14,800 times.

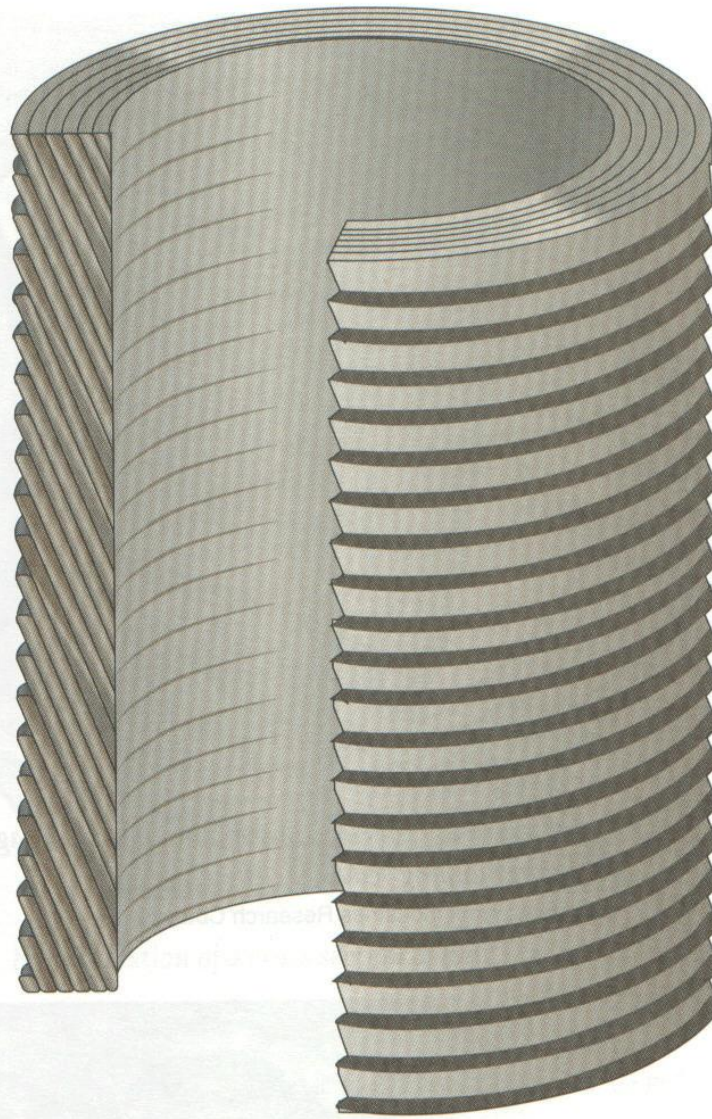


Figure 6-15 Cross section of hair showing that, although you can count six distinct layers of overlapping cuticle, each individual scale is attached to the cortex in one cuticle layer.

Penetration Occurs Between The Cuticle Scales



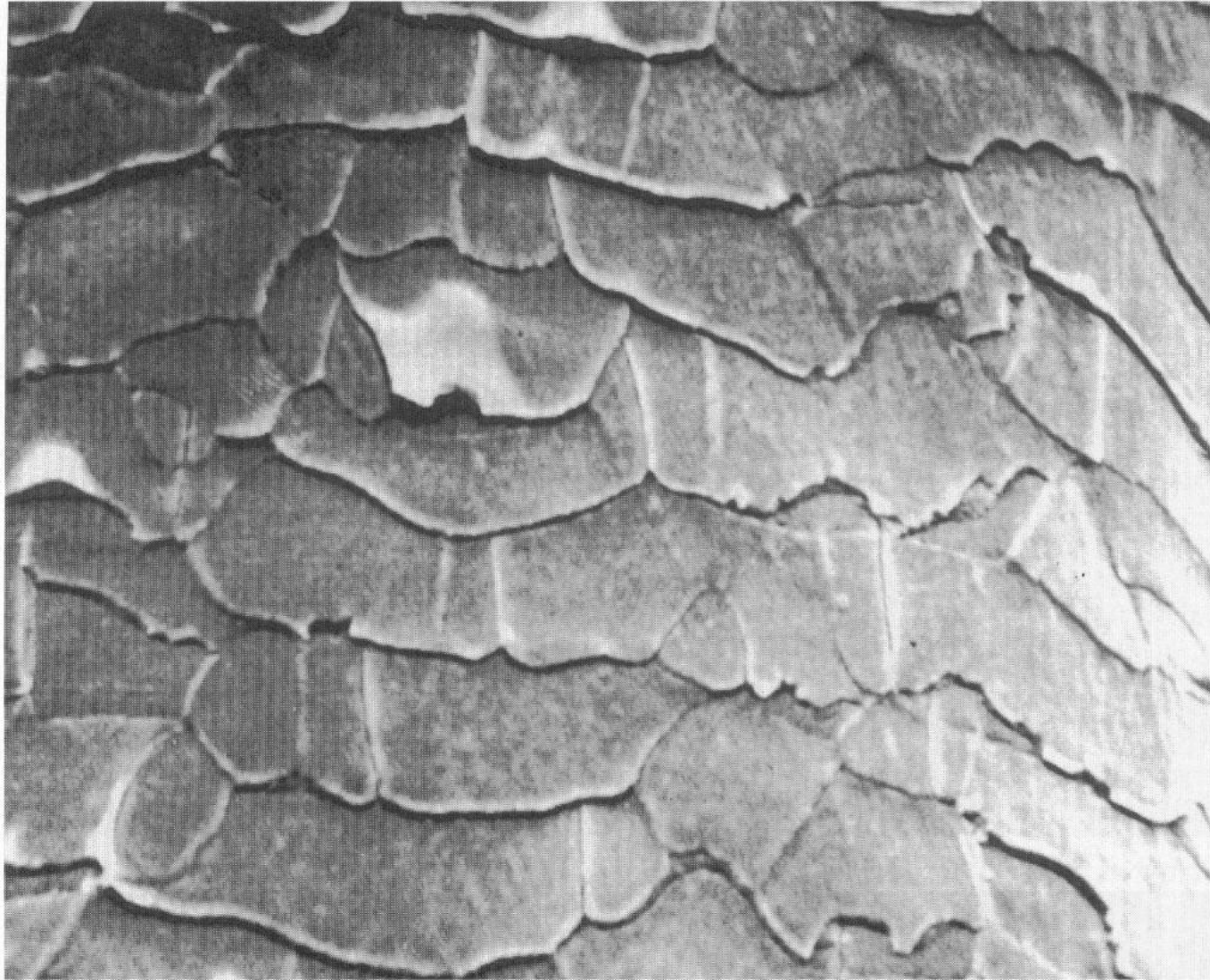


Figure 10. Cracks parallel to the fiber axis from heat drying hair (17). Reprinted with permission of the *Journal of the Society of Cosmetic Chemists*.

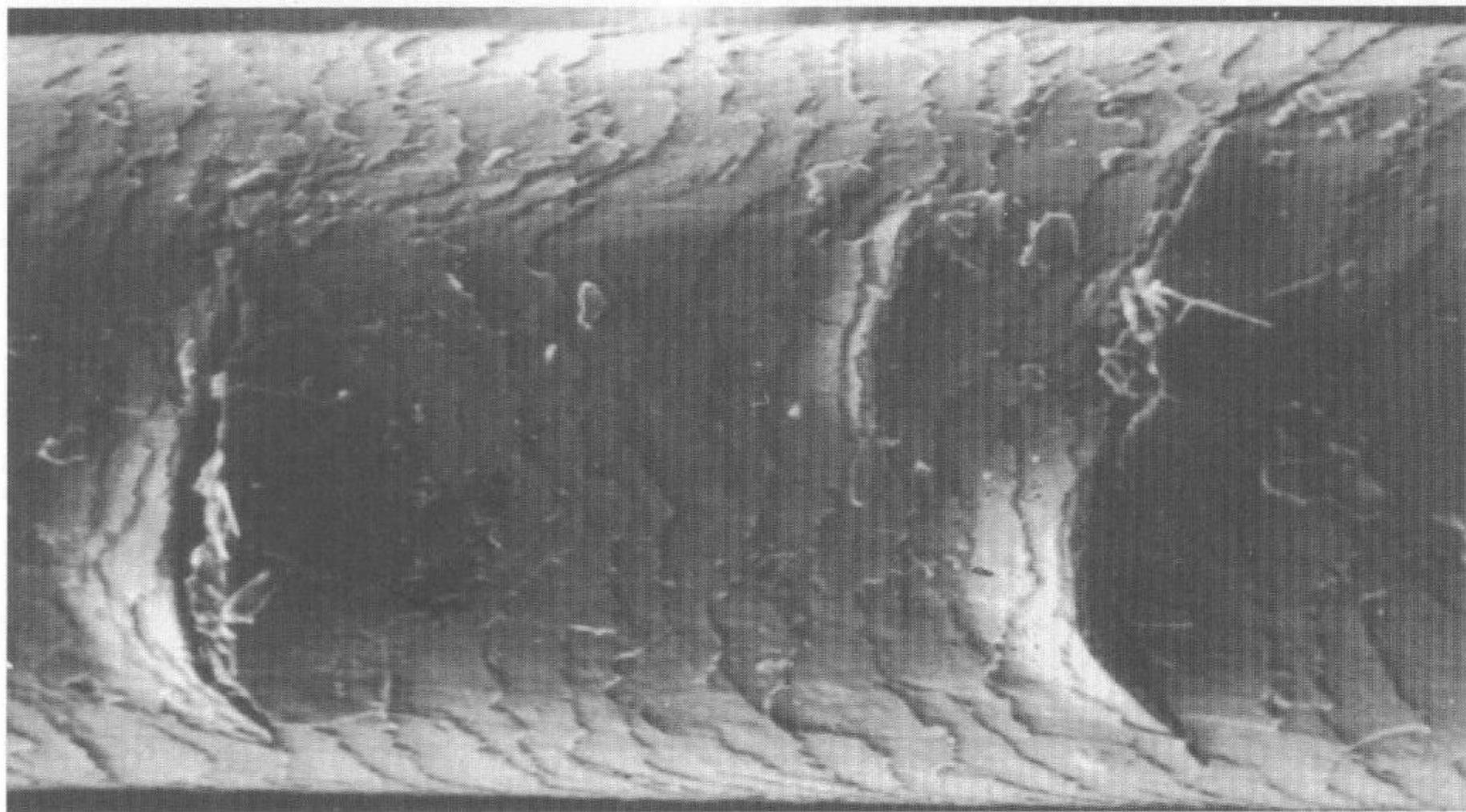


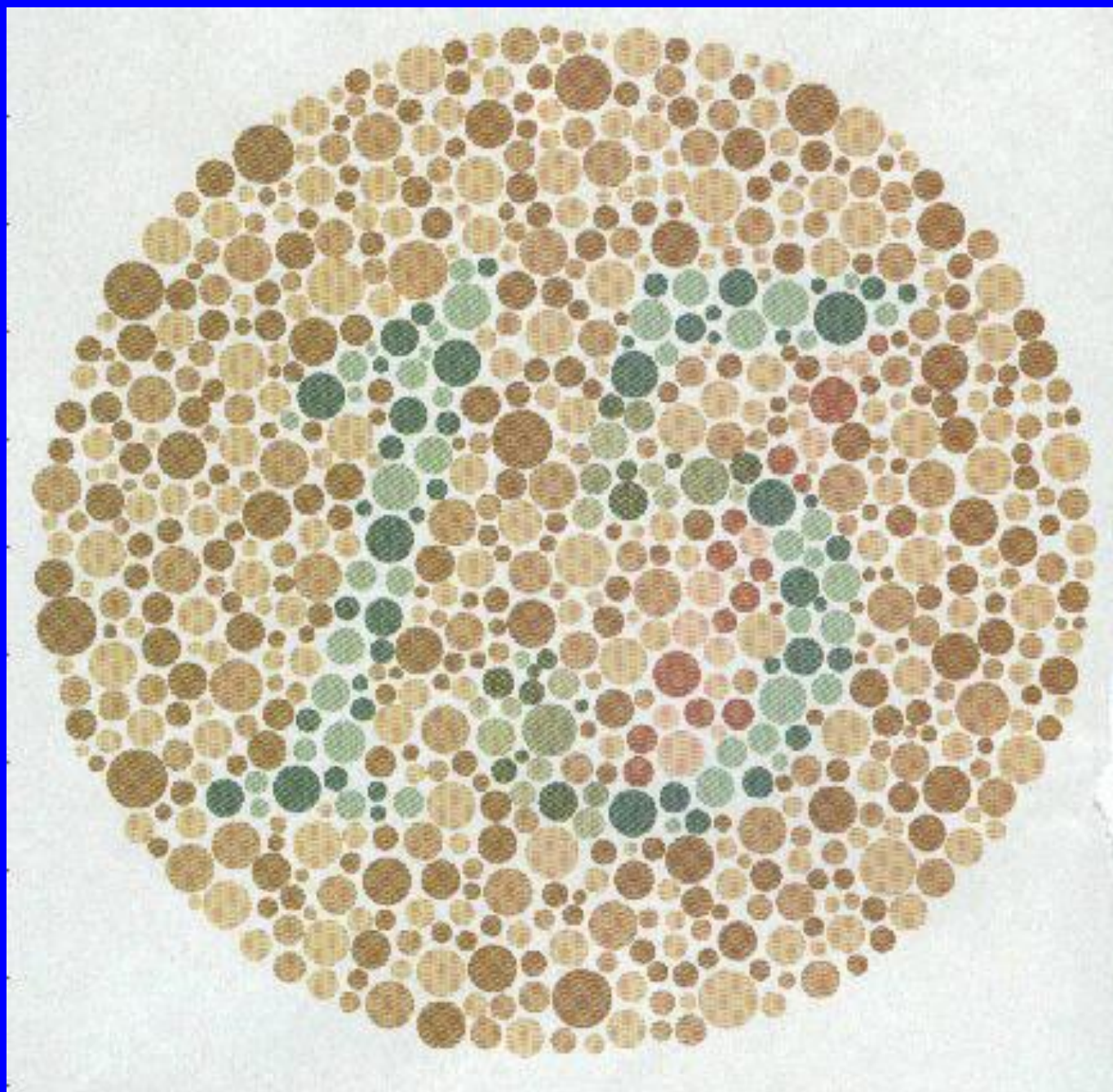
Figure 14. Deep ovoidal cracks across cuticle from simultaneously heat drying and combing wet hair (1). Reprinted with permission of Springer-Verlag.

Natural Hair Color



Artificial Haircolor





Subtractive Color

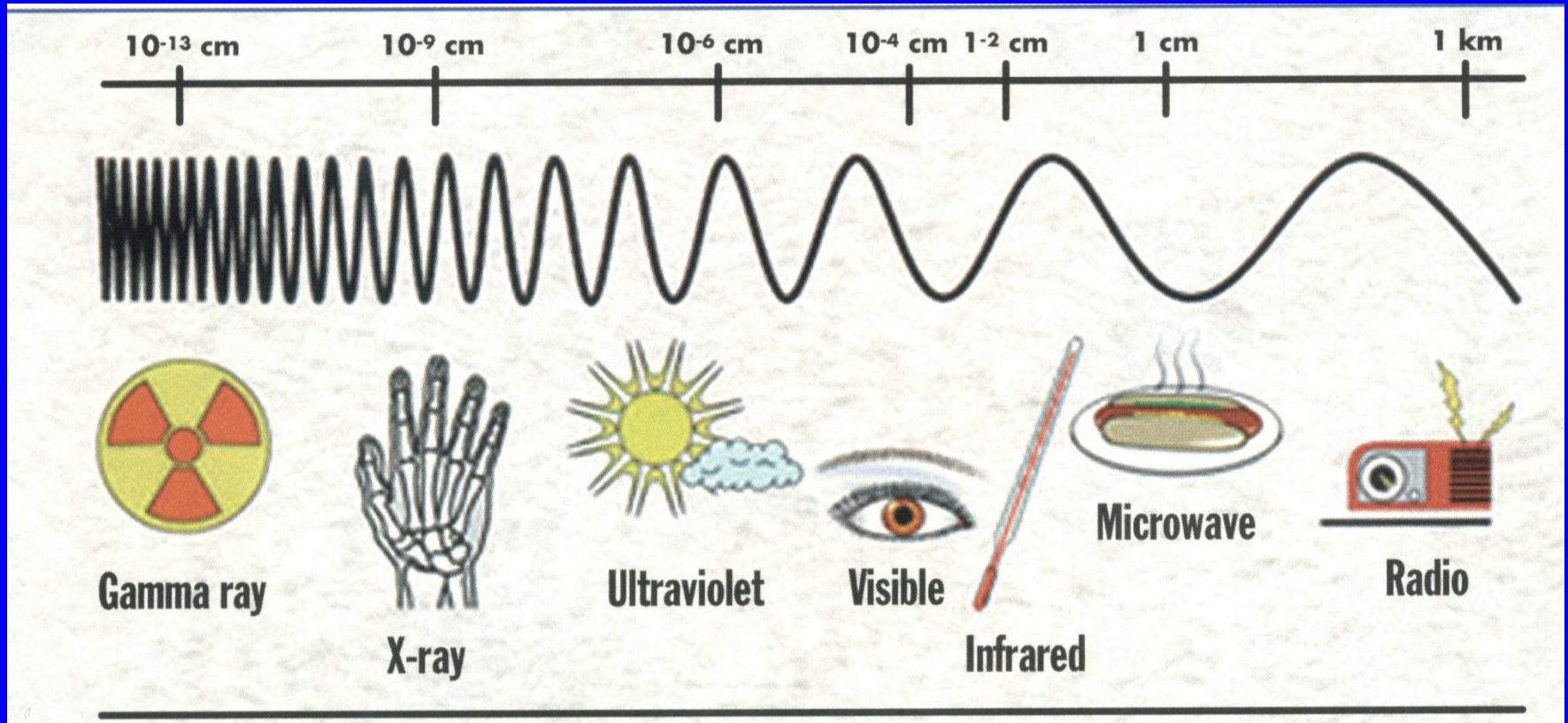
Reflects Available Light

What color is your hair
If you turn out all the lights?

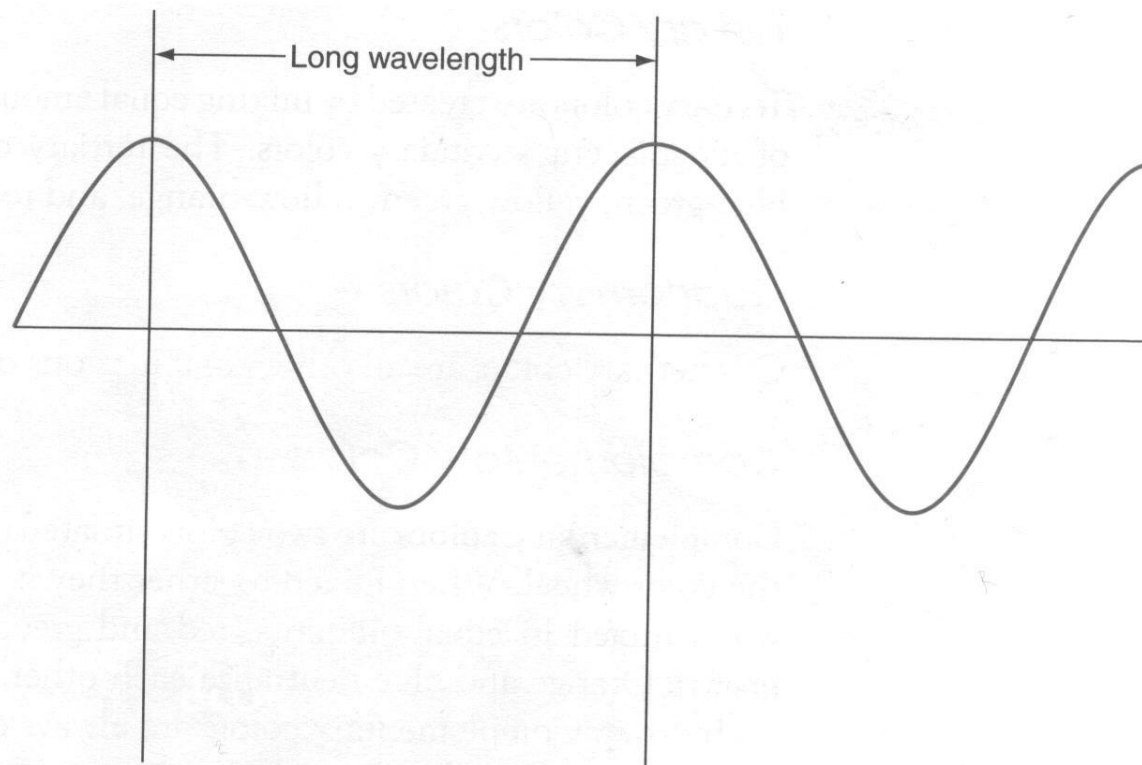
- Fluorescent Lights - Green
- Tungsten Lights - Orange
- Bright Daylight - White

NATURAL LIGHT CONDITIONS	KELVIN COLOR TEMPERATURE	ARTIFICIAL LIGHT SOURCE	COLOR TINT MIXTURE
<ul style="list-style-type: none"> • Fair weather, blue sky 	10,000	<ul style="list-style-type: none"> • Color television 	Bluish
<ul style="list-style-type: none"> • Slightly cloudy sky • Cloudy or rainy sky 	8,000 7,000 6,500	<ul style="list-style-type: none"> • Fluorescent lamp (Daylight) • Camera flash bulb 	
<ul style="list-style-type: none"> • Sunlight in clear weather at midday 	6,000 5,500	<ul style="list-style-type: none"> • Blue lamp for photography 	
<ul style="list-style-type: none"> • Average sunlight in clear weather 	5,000		
<ul style="list-style-type: none"> • Sunlight 2 hours after sunrise and before sunset 	4,500 4,000 3,500	<ul style="list-style-type: none"> • Fluorescent lamp (White) • Normal flash bulb • Fluorescent lamp (Off-white) • Tungsten lamp for photography 	Whitish
<ul style="list-style-type: none"> • Sunlight 40 min. after sunrise and before sunset 	3,200	<ul style="list-style-type: none"> • Halogen lamp • Iodine lamp 	
<ul style="list-style-type: none"> • Sunlight 30 min. after sunrise and before sunset 	2,800	<ul style="list-style-type: none"> • Tungsten lamp • Acetylene lamp • Kerosene lamp 	Yellowish
<ul style="list-style-type: none"> • Sunlight 20 min. after sunrise and before sunset 	2,000	<ul style="list-style-type: none"> • Candlelight 	Reddish

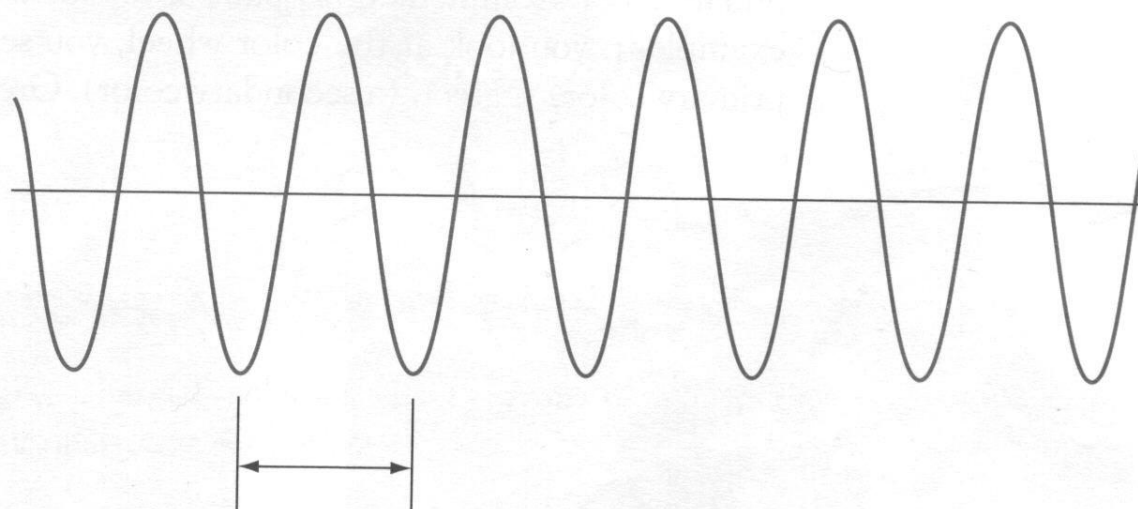
The Electromagnetic Spectrum



Low
frequency



High
frequency



Color Theory

1) Level of Color

Concentration, Density, or Saturation
How Much Color?

White, Black, & Gray

The Same Color - Different Levels

Pink is a Lighter Tint of Red

2) Shade or Hue of Color

Balance of Color, Tone or Hue

Which Color?

	COOLER/MAS FRIO			NEUTRAL/NEUTRO		WARMER/MAS CALIDO			
	ASH/CENIZO			NATURAL/NATURALES		GOLD/DORADOS		RED/ROJOS	
10	1001 Super Shimmery Ash Blonde Rubio Cenizo Muy Platinado	1030 Platinum Ash Blonde Rubio Cenizo Muy Platinado	1060 Super Ash Blonde Rubio Cenizo Super			1036 Heavy Blonde Rubio Muy Oscuro	1070 Heavy Shimmery Blonde Rubio Suro Negro Muy Oscuro		
9		940 Pale Ash Blonde Rubio Platinado Cenizo		911 Very Light Blonde Rubio Muy Claro					
8	882 Light Shimmery Ash Blonde Rubio Suro Cenizo Claro		740 LT Light Ash Blonde Rubio Cenizo Claro	811 Light Blonde Rubio Claro		831 Beige Blonde Rubio Beige	841 Light Golden Blonde Rubio Ligero Dorado	729 Tobacco Red Blonde Rubio Rubro	892 Light Bright Red Rubio Brillante Claro
7	672 Medium Shimmery Ash Blonde Rubio Suro Cenizo Mediano			711 Medium Blonde Rubio Mediano			725 Sunlight Blonde Brown Rubio Castaño Brillante	643 Tan Blonde Rubio Tonante	
6	462 Dark Shimmery Ash Blonde Rubio Suro Cenizo Oscuro	632 Medium Ash Blonde Rubio Cenizo Mediano	542 Ash Blonde Rubio Cenizo	611 Dark Blonde Rubio Oscuro		555 Neutral Blonde Rubio Neutro	544 Light Copper Cobre Claro	633 Red Blonde Rubio Rojo	607 Carmine Carmin
5		336 Light Shiny Brown Pardo Castaño Claro		511 Light Brown Rubio Claro				445 Light Auburn Castaño Rubro Claro	507 Burgundy Rojito Vino
4		237 Medium Ash Brown Castaño Cenizo Mediano	246 Light Ash Brown Castaño Cenizo Claro	411 Medium Brown Castaño Mediano		435 Light Golden Brown Castaño Dorado Claro	356 Cinnamon Brown Castaño Canela	347 Dark Auburn Castaño Rubro Oscuro	
3				311 Dark Brown Rubio Oscuro		257 Dark Golden Brown Castaño Dorado Oscuro			367 Black Cherry Cereza Negro
2	148 Dark Ash Brown Café Cenizo Oscuro			211 Dark Ash Brown Café Cenizo Oscuro					
1	052 Blue Black Negro Azulado		051 Black Negro						
						MODIFIERS/MODIFICADORES			
						050 Light Drabber Pardo Claro	049 Dark Drabber Pardo Oscuro	042 Gold Dorado	010 Red Ash Rubio Rojo

10 Stages of Decolorization

- Lightening Natural Color Makes it Warmer
- Natural Hair Color
 - 3 Parts Yellow
 - 2 Parts Red
 - 1 Part Blue

Oxidative & Non-oxidative Color

1) Non-oxidative

- Temporary
- Semi-Permanent

2) Oxidative

- Demi-Permanent (Deposit Only)
- Permanent (Lift & Deposit)
- All Lighteners

“Coal Tar” Dyes

- Primary Intermediates – Provide Base Color
 - Para-Phenylenediamines (PPD)
 - Para-Aminophenols (PAP)
- Couplers/Secondary Intermediates– Modify Color
 - Meta-Phenylenediamines
 - Meta-Aminophenols
 - Resorcinols
- Cosmetic Toiletries & Fragrance Act of 1938
 - Patch Test 48 hours prior to EACH application
 - Not for use on eyelashes or eyebrows

Alkaline Haircolor

- 1) Swells the hair to gain entry
- 2) Triggers the decomposition of peroxide
- 3) Aids in developing the dye

Inorganic Alkalizing Agents

- Ammonia, NH_3 (17 aw)
- Ammonium Hydroxide, NH_4OH (35 aw)
- Sodium Hydroxide, NaOH (40 aw)

Organic Alkalizing Agents

Alkanolamines, R-NH_2

- Aminomethylpropanol (AMP) (89 aw)

Deposit Only

- Monoethanolamine (MEA) (61 aw)

Lightening

Oxidizers

- Oxidation is necessary to:
 - 1) Develop the dye
 - 2) Lighten the natural hair color

- Examples of oxidizers

Sodium Bromate NaBrO_3 Sodium Perborate NaBO_3

Hydrogen Peroxide H_2O_2 Atmospheric Oxygen O_2

Urea Peroxide $\text{CH}_2\text{N}_2\text{O} \cdot \text{H}_2\text{O}_2$

Hydrogen Peroxide H_2O_2

- Solution of Hydrogen Peroxide and Water
 - 20 Volume
 - 6% Hydrogen Peroxide
 - 94% Water
 - 40 Volume
 - 12% Hydrogen Peroxide
 - 88% Water

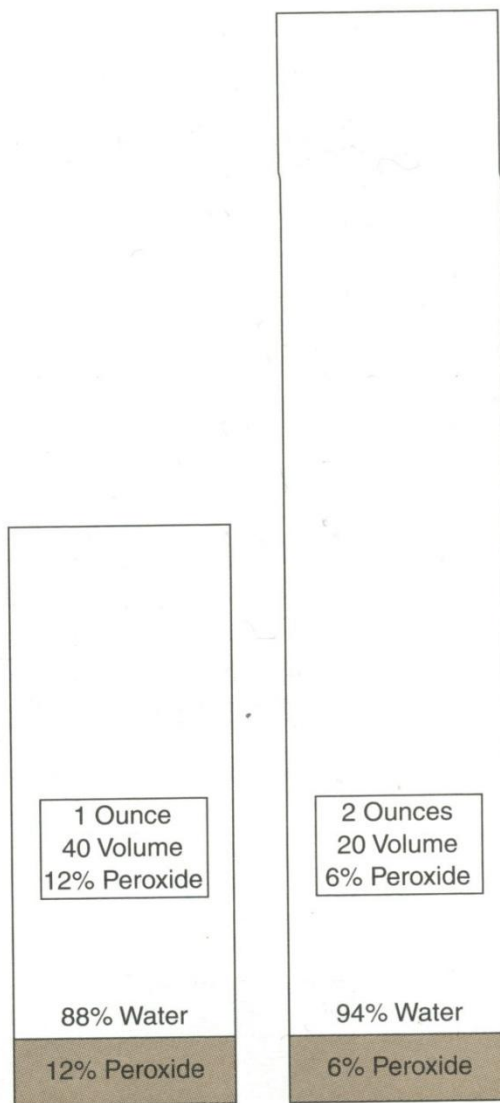


Figure 11-24 This illustration shows that one ounce of 40 volume peroxide contains the same amount of peroxide as two ounces of 20 volume peroxide. The 40 volume simply contains less water.

When You Mix Equal Parts Color & 20 Volume You Apply 10 Volume to the Hair

The Effective Volume is the relationship of:

- 1) The total amount of the color mixture
- 2) To the amount of peroxide
- 3) To the volume of peroxide

- 2 ounces Color
- 2 ounces 20 Volume

- 1) $2 + 2 = 4$ ounces total
- 2) $4 / 2 = 2$, $\frac{1}{2}$ is peroxide
- 3) $20 / 2 = 10$ effective volume

- 3 ounces Color
- 1 ounce 40 Volume

- 1) $3 + 1 = 4$ ounces total
- 2) $4 / 1 = 4$, $\frac{1}{4}$ is peroxide
- 3) $40 / 4 = 10$ effective volume

Clarifying Treatment

Formula

- 1 Ounce - Fruit Fresh (Ascorbic Acid/Vitamin C))
- 1 Ounce - Warm Water
- 1 Ounce - Clarifying Shampoo

- Shampoo with Clarifying Shampoo
- Mix Fruit Fresh and Warm Water
- Add Clarifying Shampoo and Mix Well
- Apply to Damp, Towel Dry Hair
- Cover with Plastic Cap with Holes
- Place Under Hot Dryer for 10 Minutes
- Shampoo with Clarifying Shampoo

“Resistant” Gray Hair

Not Resistant - Just White

- The structure of non-pigmented hair is identical to that of pigmented hair except for the absence of melanin.
- Non-pigmented hair is no more resistant than the pigmented hair on the same head. It's just white.
- “Gray” hair is more difficult to color only because it is white and needs more color.

Grey Hair Deposit Only

Formula

3 Ounces - Haircolor

1 Ounce - 30 Volume Peroxide

4 Ounces - 7.5 Effective Volume

- 3 Parts Yellow, 2 Parts Red, 1 Part Blue
- Level 6 or Darker
- Apply to Clean Damp Hair
- Process 30 minutes at room temperature

High Lift

Formula

1 Ounce - Haircolor

2 Ounces - 40 Volume Peroxide

3 Ounces - 27 Effective Volume

- Level 8 to 10 with a Blue or Violet Base
- Add ½ ounce of Powder Lightener
- Apply to Clean Damp Hair
- Process 30 minutes, at room temperature

The rate of a chemical reaction diminishes over time

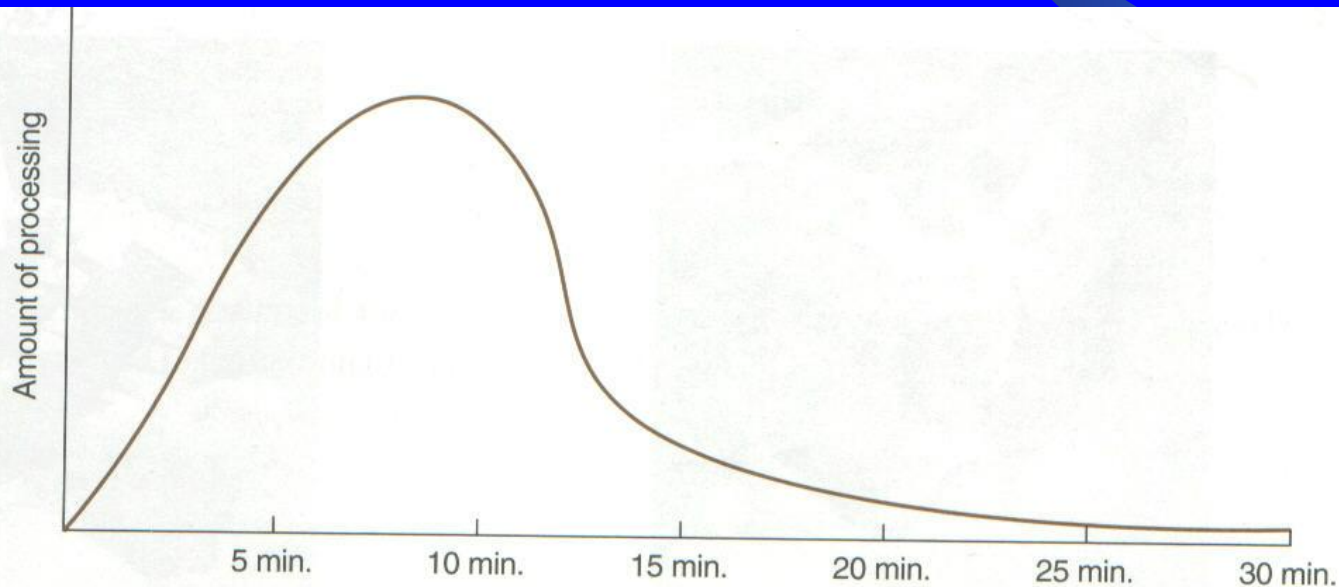


Figure 13-22 The graph shows that the rate of most chemical reactions is not uniform over time. The rate of reaction begins slowly until the chemicals penetrate the hair, then drops sharply as the reactants are “used up” and converted to products. Most chemical reactions have very little chemical activity after 20 minutes.

Off-The-Scalp Lighteners

- Persulfate Salts
 - Ammonium Persulfate, Potassium Persulfate, Sodium Persulfate
- Anhydrous - Powdered Form Only
 - Powder Lighteners, Cream Bleach Activators
- CAUTION – SCALP IRRITATION
 - Mix Before Each Use.
 - Off Scalp Only
 - Do Not Use Heat

Woofle Dust

- Enzymes
- Liquid Color Accelerators (Vitamin E)
- Ozone O_3
- Processing Machines Use Heat
 - 18 degrees Fahrenheit doubles the rate of reaction
 - Not uniform
 - Damages hair structure
- Evaporation (plastic bag with holes)

Olaplex

bis-(maleimidoethoxy) ethane

bis aminopropyl diglycol dimaleate (INCI)

- Form crosslinks with thiols
- Specific pH 6.5 to 7.5
- Ph 8.0 is 1,000 times slower than ph 7.0
- 246 atomic weight. It's big.
- Wouldn't do much for healthy hair.
- Can you perm after?
- Does it work with Hydroxide relaxers?

pH

The Story of H^+ and OH^-

- pH is the negative logarithm of the concentration of hydrogen ions.
- Although everyone talks about pH, most have no idea what it is or how it works.

The Natural Ionization of Water

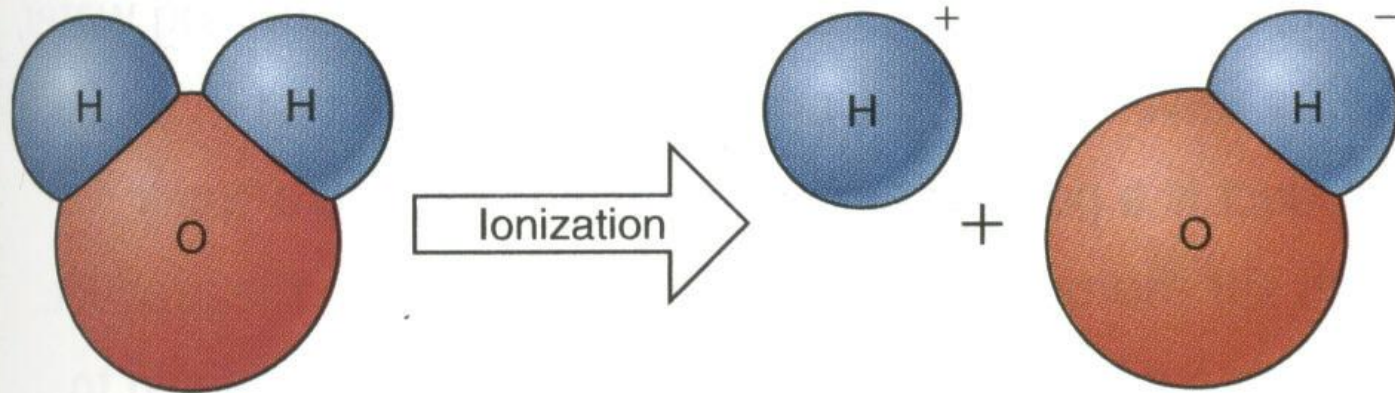
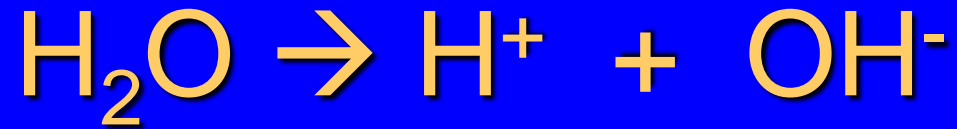


Figure 7-10 The ionization of water.

The Ionization of Water Means

- That pH is only possible because of the ionization of water. Only aqueous (water) solutions have pH. Oil and alcohol do not have a pH.
- Pure water isn't neutral because it is neither acidic nor alkaline. Pure water is neutral because it is an even balance of both.

The pH Scale



pH	H^+ Hydrogen Ion		OH^- Hydroxide Ion	
	Exponential Notation	With Decimal	Exponential Notation	With Decimal
0	1×10^{-0}	1.	1×10^{-14}	.000000000000001
1	1×10^{-1}	.1	1×10^{-13}	.00000000000001
2	1×10^{-2}	.01	1×10^{-12}	.0000000000001
3	1×10^{-3}	.001	1×10^{-11}	.000000000001
4	1×10^{-4}	.0001	1×10^{-10}	.0000000001
5	1×10^{-5}	.00001	1×10^{-9}	.000000001
6	1×10^{-6}	.000001	1×10^{-8}	.00000001
7	1×10^{-7}	.0000001	1×10^{-7}	.0000001
8	1×10^{-8}	.00000001	1×10^{-6}	.000001
9	1×10^{-9}	.000000001	1×10^{-5}	.00001
10	1×10^{-10}	.0000000001	1×10^{-4}	.0001
11	1×10^{-11}	.00000000001	1×10^{-3}	.001
12	1×10^{-12}	.000000000001	1×10^{-2}	.01
13	1×10^{-13}	.0000000000001	1×10^{-1}	.1
14	1×10^{-14}	.00000000000001	1×10^{-0}	1.

Figure 9-3 The quantities of the pH scale expressed as pH, exponential notation, and with a decimal point.

The pH Scale is Logarithmic

- pH is the negative exponent - decimal places
- A pH of 7.0 is 50% alkaline & 50% acidic
- pH of 7.0 is neutral for water - alkaline for hair
- Place a dollar sign in front of the decimal.
 - Each whole step is a tenfold change.
 - Two whole steps is a one-hundred fold change.

Acid – Alkali Neutralization

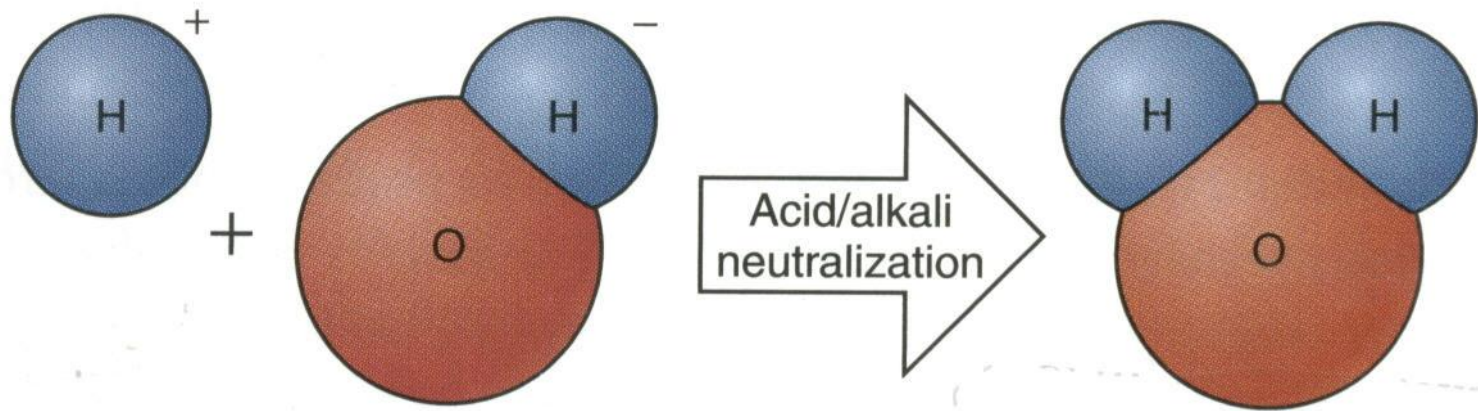
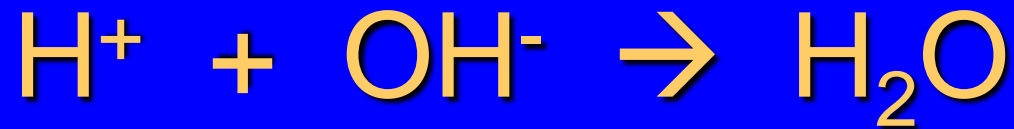


Figure 7-12 Acid/alkali neutralization reaction.

Dilution Is Not the Solution

- Allured Publishing
 - (630) 653-2155 or www.allured.com
 - The Chemistry and Manufacture of Cosmetics
 - Beginning Cosmetic Chemistry
 - Cosmetics and Toiletries Magazine
- Harry's Cosmeticology, Chemical Publishing Co.
- Global Cosmetic Industry Magazine
 - (800) 598-6008 or www.globalcosmetic.com
- Society of Cosmetic Chemists
 - (212) 668-1500 or www.scconline.org

The Copernican Revolution

- The earth is the center of the universe.
The sun revolves around the earth.
- Nicolaus Copernicus, 1473 to 1543
- Galileo Galilei, 1564 to 1642
- Sir Isaac Newton, 1642 to 1727