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Hair…

- hair is an optimized assembly of:
- **proteins → keratin:** rich in **half-cystine** **serine** **glutamic acid** **proline** → provide **mechanical strength**
- **Water** is also part of the hair **keratin** composition \because it is needed for its **stability**
- **Polysaccharides**
- **Lipids**

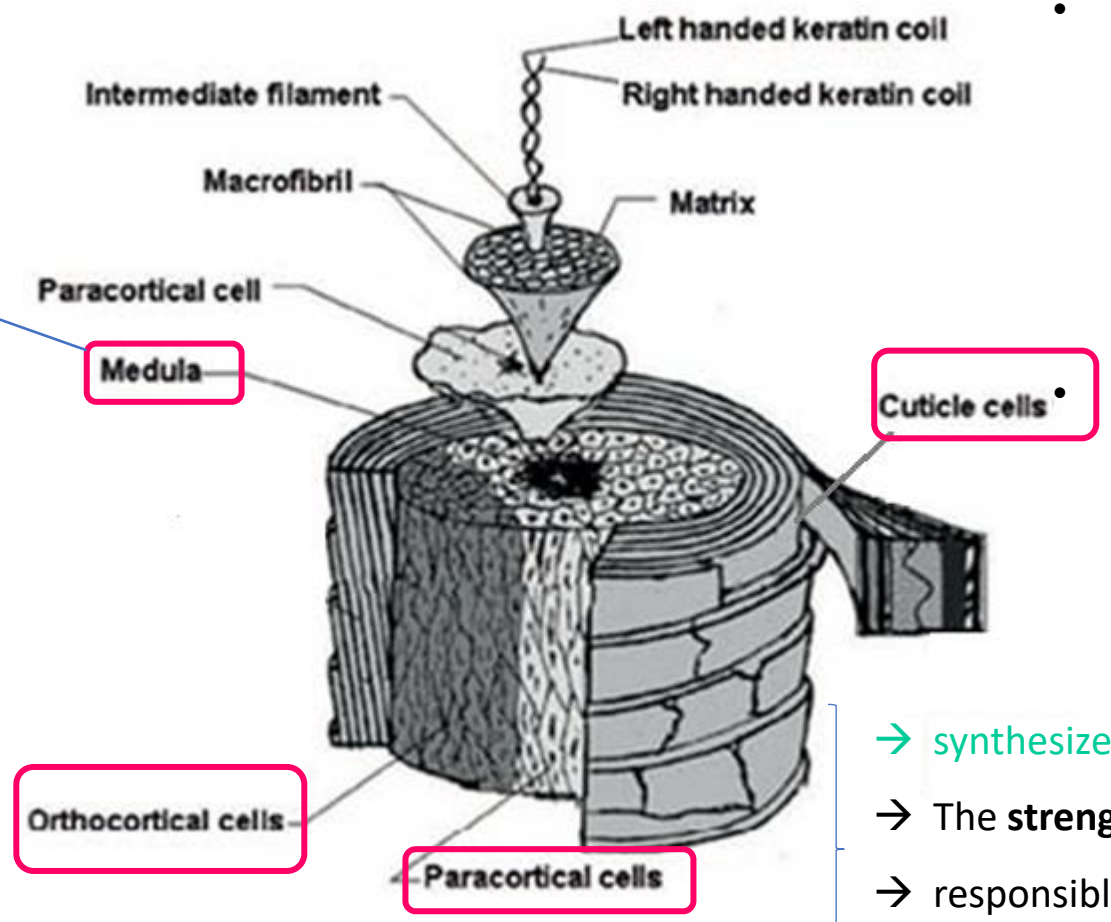
  2–10% of the fiber weight

  mainly appear in the **cement layer** gluing **cortical & cuticle** cells, as well as on the **hair surface**

  - composed of fatty acids, ceramides, & cholestaerol
- **Integral hair lipids** → important in the maintenance of **hair integrity** due to **hydrophobicity, moisturization, & stiffness**
- the **very top layer** of a hair fiber (**F layer**) is made up of a **fatty-acid chain**, the 18-methyl eicosanioc acid (18-MEA)
- **the waxy part** of the 18 MEA protrudes away from the epi-cuticle surface→ provide the **highly needed lubricity & hydrophobicity of hair fibers**

- responsible for the **visual attributes of hair** → **shine & smoothness**.
- **cellular envelope** acts as an **effective shield** that **protects** the **cortical cells** against **friction** **mechanical abrasion** **impact** **other environmental stresses** ➔ extend the life of hair
- a **gate** to control **incoming & outgoing light** from the cortex → provide **protection against radiation** & **color**

is only present in **large & thick hairs**



Cortex

- → synthesize **keratin** in their bodies
- → The **strength, color, & texture** of a hair fiber
- → responsible for the **mechanical properties** of the fiber

Shape-memory properties of hair

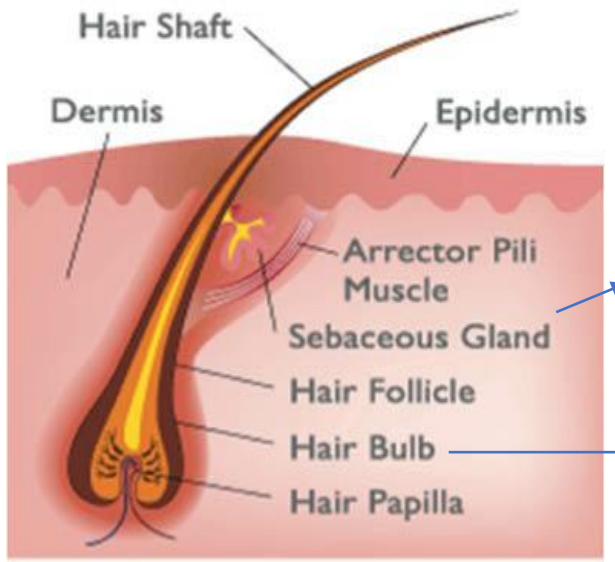
Viscoelasticity & **the shape-memory properties of hair**

Water & moisture absorption/desorption

- **different packing density** ➔ **the viscoelastic response** of the hair section filled with **para-cortical** cells is **different** from **ortho-cortical cells.**
- the **ortho-cortical cells** absorb **less moisture** < the **para-cortical** cells ➔ lower degree of **water plasticization**

- **THE FOLLICLE**

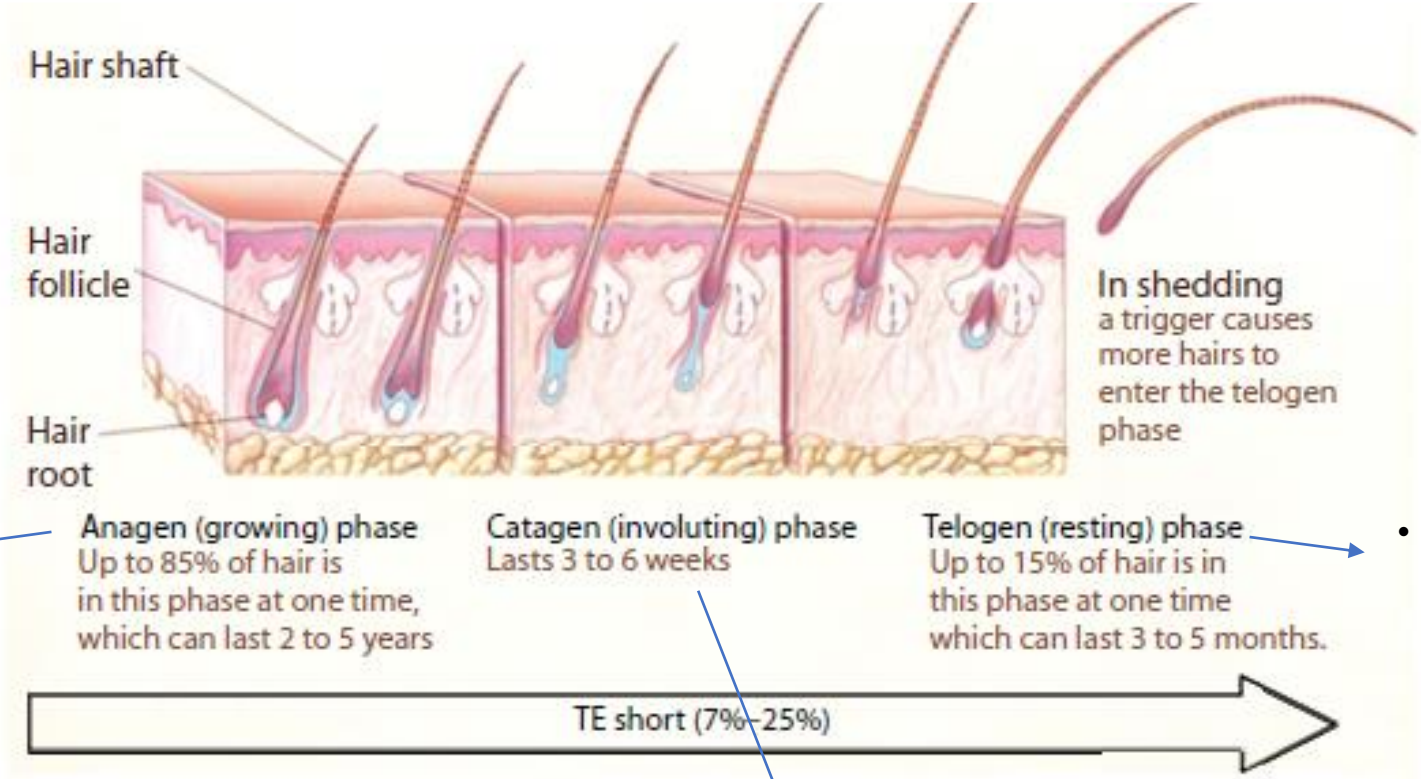
- composed of various **biological units**, namely: **bulb** **dermal papilla** **bulge** **external & internal root sheath**
- follicles are able to produce & assemble **hair cells** to form **hair fibers**.
- **the follicle** is the target of major **hormonal pathways**
- All cells forming a hair fiber are made in the follicle from **stem cells**
- The hair follicle, with all its basic internal units, **regenerates** itself ≈ every 4-6 years.
- @ the end of the 6th year of activity, the follicle gets instructions from the **body's glands & genetic system** to cease & stop the production of hair.



  - Release: **Sebum (→ hydrates** the scalp & **moisturizes** the hair by surrounding it with a **protecting microfilm) & enzymes** → to **maintain the integrity of the hair shaft**
    - deficiency → loss of **hair** elasticity the hair becomes dry, dull prone to breakage
- The intrinsic production of **sebum ↓ with age**, particularly in **females**
- that the **follicle & sebum glands** (both together: the **pilosebaceous unit**) can act as a peripheral **hormone-producing** unit for a wide range of **steroid hormones, neuro-peptides, & neutrophins**
  - contains **melanocytes:** produce **melanin**: **melanogenesis** **formed** in cytoplasmic organelles called **melanosomes.**

Life cycle of the follicle

- growth & differentiation (anagen)
- regression & apoptosis (catagen)
- rest (teleogen)



Hair growth cycle and shedding: the early conversion (or shunt) from anagen into telogen can affect 7% to 25% of hairs.

- hair fibers in the 3 zones of **cell creation, differentiation, & keratinization** are continuously assembling & growing
- intensive production of **cuticle & cortical** cells via **stem cell** **mitosis**

- the inactive parts of the follicle are pushed out & the old hair falls out.

- the **growth rate & overall characteristics of hair fibers** dependent on **certain hormones** & **nutritional** **variations**

- the follicle lowers its **cell production** & a large part of its cells undergo **apoptosis**.

- **Empty hair follicles**, after shedding of the club fiber, but before the onset of renewed **anagen**, are in a stage called **"kenogen."**
- the **frequency & duration** are significantly **greater** in individuals with **androgenetic alopecia**

- Previously, **hair fiber shedding** was believed to be **passive,** but it is an **active & highly controlled process**
- Ex, the most common alopecia, **androgenetic alopecia**, produces a **patterned baldness** → ↓the % of **scalp hair follicles** in anagen

↓ **the anagen** growth phase **duration**⇒↑ the % of hair follicles in **telogen** ↑ the **duration of telogen**

➔thinning hair coverage

❑ **Telogen effluvium** → abnormality of **hair cycling**, which appears as shifting of a % of **anagen** hairs to **telogen** ➔ excessive **loss of telogen hair.**

- functional types of **telogen effluvium** ….

○ **Immediate anagen release** → hair follicles prematurely leave anagen & enter **telogen**

➢ caused by **drug**, **mental**, or **physiological stress** such as high fever & severe illness.

○ **Delayed anagen release**→ follicles remain in a **prolonged anagen** phase rather than cycling into **telogen** → the cause of **postpartum** hair loss

○ **Short anagen syndrome** → **idiopathic shortening of the anagen period**, leading to the persistent shedding of **telogen hair**.

○ **immediate telogen release** → hair follicles have a **shortened telogen** phase & are stimulated to **re-enter anagen** → induced by **topical minoxidil**

○ **Delayed telogen release**→ when **prolonged telogen** is directly followed by **anagen initiation** → often occurs in animals shedding their winter pelage at the onset of spring

- **loss of pigmentation**
- **loss of moisture**
- **Δgrowth characteristics → ↓ hair follicle density**
- **↑ # of telogen** hairs
- **↓ the diameter** of hair shafts
- slower hair **growth rates**

- hair will become **deficient in essential nutrients**
- the hair **follicles shrink**
- loses its **elasticity**
- **less Pr** is produced in the hair follicle
- **lipid & keratin** production diminish
- **many** hair follicles **stop** producing **new hairs** altogether.
- The # of **inter-follicular SCs** →↓ with age
- The **diameter** of the **scalp hair shaft** (except in the **occipital area)**→ ↓ with age

Aging

internal changes

Genetic

Diseases: inflammation, stress

Physiologic event: Postpartum/Surgery

Hormonal:

- **DHT**
- **estrogen**

thin
dry
less manageable
brittle
less shiny
hair fall

external Factors

cigarette smoke
car exhaust fumes
smog
ozone (particularly when hair is **wet**)
gaseous sulfur dioxide (SO2)
UV Radiation
Diet/Drug
Chemical/Mechanical treatments (friction hair combing hair dyeing permanent waving**)**
Lifestyle: weight loss

hair **damage**
dull
brittle hair

Select Medications Known to Induce Telogen Effluvium

Psychotropics	Anticoagulants (LMW Heparins)	Cardiovascular	Antimicrobials	Retinoids
Most common	**Most common**	**Most common**	*Anti-tuberculoid*	• Isotretinoin
• Lithium	• Enoxaparin	*Beta blockers*	• Isoniazide	• Acitretin
• Valproic acid	• Dalteparin	• Metoprolol	*Anti-retrovirals*	• Bexarotene
• Fluoxetine	• Tinzaparin	• Propranolol	• Indinavir	
Less common	**Rare**	*ACE-inhibitors*	• Combination therapies	
TCAs	• Warfarin	• Captopril	*Antifungals*	
• Imipramine		• Enalapril	• Ketoconazole	
• Desipramine		**Rare**	• Fluconazole	
Other SSRIs		• Amiodarone		
• Sentraline				
Rare				
• Carbamazepine				

❑**Chronic exposure** to diverse stimuli **imbalance** between **inflammatory & anti-inflammatory mechanisms** with ↑ age → **chronic low-grade** pro-inflammatory status→ *inflamm-aging*

- **Stress**→ release of **substance P (SP)** from **nerve endings** → can trigger **mast cell**-dependent **neurogenic inflammation** around the **hair follicles** → **alopecia areata (AA)** **scarring alopecia stress-associated collapse** in hair

❑ Hormones

➢ androgens estrogens thyroid parathyroid prolactin corticosteroids GH/IGF-1 melatonin

→ recognize **pathologic conditions** & **treat** them appropriately.

❑ **Melatonin**, the chief secretory product of the **pineal gland** → **modulate hair growth** & **pigmentation** as a key **neuro-endocrine regulator** that couples coat phenotype function to **photoperiod**- dependent environmental & reproductive changes.

- Important **extra-pineal melatonin synthesis** → in human scalp **hair follicles** in **anagen** → functionally play a role in **hair-cycle control**, as it **down-regulates apoptosis**
- → as a **free radical scavenger** & **DNA repair inducer**
- the metabolically & proliferatively highly **active anagen hair bulb** may also exploit **melatonin synthesis** *in loco* as a **self-cytoprotective strategy**
- Topical application of **melatonin** → director **radical scavenger** & **anti-aging agentenhance** human hair growth
- **Topically applied melatonin** influences **hair growth & shedding**…?

❑ the growth of **di-hydro testosterone (DHT) hormone** on the scalp is responsible for **hair loss** → makes hair follicles **weaker & weaker** by **blocking** the **nutrients & water** to the hairs.

- the amount of DHT ↑ with ↑ age
- → **Hair loss treatment** products are mostly designed to act as **DHT blockers… Minoxidil**
  - treat **male pattern baldness**
  - Neither is fully effective in **all cases**
  - need l**ong-term** administration or there will be re-currence
  - must be **prescribed** on private prescription.

❑ The anti-aging effect of **estrogens** on hair growth …? → **stimulatory effect** of estrogens on **human hair growth**

- estrogens influence hair **follicle growth** & **cycling** by binding to **locally expressed high-affinity** estrogen receptors (ERs).
- The **thinning of hair** in **women** may become rather more pronounced after **menopause** when there are fewer **estrogen hormones** to **counteract** the **androgens.**
- The **hair density** in **women** without Androgenic Alopecia (AGA) did not differ significantly over **the occipital scalp** before & after **menopause**, while the **density** over **the frontal area** declined significantly
- The **growth rate** of scalp hair in **women** **slows down** with age ↓ **anagen %,** **hair diameter distribution**

- During **the second half of pregnancy**: the % of **anagen hairs** ↑ from the normal **85%** → **95%** hairs of **large shaft diameter** is higher > in **non-pregnan**t women of the same

- **After partuition**, the follicles, in which anagen has been prolonged, **rapidly** enter **catagen** & then **telogen** → with ↑ shedding of hair evident after **1–4 months** (**postpartum effluvium**).

- many women show ↑ shedding of hair from **2 weeks - 3–4 months after** they **stop** taking an **oral contraceptive**

❖ More frequently, **contraceptive pills** or **hormone replacement therapies** with **progestogens** that **possess net androgenic activity** (norethisterone, levo-norgestrel, tibolone) induce **common baldness** in **genetically predisposed women.**

❖ **Hormone therapy** with **androgens** **androgen precursors** (DHEA) **progestins** with **androgenic action** → may cause **hair loss** in individuals with **androgenetic alopecia**.

❖ In the presence of a **genetic susceptibility**→ **the estrogen/androgen ratio** → might be responsible for triggering **hair loss in women**

- **hair loss** induced in the susceptible women by **treatment** with→ **aromatase inhibitors** for breast cancer

- **Soy extracts** had no such effect & may even **exacerbate hair loss**

- Estrogen → have direct effect on ↑ **dermal glycosaminoglycan (GAG)** & **enhancing vasodilatation** in the cutaneous microcirculation of women

- **Hypo-estrogenemia** include reduced level of skin collagen & reduced skin thickness

❑ **hair dryness**→

- use of **alcohol-containing** hair products
  - exposure to alcoholic cosmetic products **solubilizes lipids** & **removes them** from hair surface.
- frequent **washing** of hair with **harsh surfactants**
- frequent **blow-drying**

} removes **cuticle lipids**

➢ **lipid replenishment** protects the hair from further damage.

❑ **Permanent hair coloring** → Δ hair **fiber properties** due to **oxidative damage** of hair **proteins & lipids**: ammonia & H_2O_2

- The **oxidation of lipids** makes the hair **dry & dull**
- the oxidation of the **disulfide linkage** of the keratin makes the hair fiber **weaker**

- **after-color conditioners** → used right after coloring to provide conditioning shine color protection.
- Regular use of products formulated for **colored hair** provides **conditioning, shine**, & **overall youthful appearance**.

❑ UV Radiation

- **The hair shaft structure & color** are directly altered by UV radiations. particularly **UVB** →hair damage

➢ hair follicle submitted to **low UVB doses→ oxidative DNA damage**

➢ **Sunlight→** lipid, protein, & melanin **oxidation** ➔ ex, impairs the structure of the **hair shaft keratin fiber**

- makes hair **more porous** because hair dyes are **water soluble** the **dye leaches out** more readily during **shampooing & rinsing**.
- →↑**surface roughness: more brittle stiffer ↓ water absorption capacity drier more prone to alkaline attack**

○ **chromophores** in hair **proteins** absorb **UVB** → Cystine, tyrosine, phenylalanine & tryptophan **absorb** UVB radiation➔ the formation of **free radicals**.

➢ UV exposures can modify some aspects of the **hair cycle** ➔ ↑the **severity** of **specific hair loss disorders** (ex, in **androgenetic alopecia**)

- Upon exposure to **repetitive UVB irradiation** → ↓ **hair shaft elongation** **premature entry into the catagen phase.**

➢ UV exposures → influence **scalp chrono-biology**.

- **Light-modulated hormones** (e.g., **melatonin**) locally released mediators

❖ **Humidity** may ↑ the effects of UV light The **rate of destruction** of tryptophan in **non-polar** media (mineral oil) << in water

❖ **Dyes fragrances carbomer type thickeners →** exhibit varying degrees of **instability** upon **exposure to light**

- **visible & UVA** light are largely responsible for **artificial hair color fading.**

- UVA irradiation can **penetrate deeply** into the **cortex** → photochemical changes

- **Hair pigments** → provide some **photochemical protection** to hair proteins, especially @ lower λs

  ❖ However, in the process of protecting the **hair proteins** from light, the pigments are **degraded** or **bleached**.

- ›› **Dark hair** is **more resistant** to photodegradation > **light hair**

  - the higher **photostability of eumelanin** > **pheomelanin** are similarly **sensitive** to **VIS light**

- **hair damages** caused by UV exposure are related to→ the **melanin type** of each hair the **total amount** of melanin.

- **dark hairs** have more **melanin** & more **photosensitive AAs** > **light hairs**.

  - Melanin can attribute photo-protection to hair protein, but only in **the cortex**.

  - As **dark hair** → can show a **greater protein loss** > **light hair** in the **cuticle region**.

- **Artificially colored hair** affords **less protection** to the hair since these compounds are **more sensitive** to decomposition by sunlight → **naturally colored** hair **retains** its color **longer** > **artificially colored** hair.

❑ Hair graying: Canities

- **Follicular melanocytes** show **cyclical activation** → "melanogenesis" is coupled with **anagen:** *anagen-coupled melanogenesis*

  During the **telogen** phase, no melanin pigment is actively synthesized

- mechanisms → **pigmentary machinery** malfunction or loss **melanocyte apoptosis** **anagen defects** **the loss of melanocyte stem cells** or **their failure to differentiate** **melanocyte migration defects**

- The **age of graying** onset is **genetically** controlled & inheritable

- Due to the **accumulation of large amounts of ROS** via **oxidation of tyrosine & dopa to melanin** in the **melanin synthesis** process during **anagen** phase → **hair bulb melanocytes** are especially susceptible to free radical-induced **aging.**

- **ROS** accumulate in human **gray/white scalp follicles** → cause **oxidative damage** to the **hair follicle melanocytes**

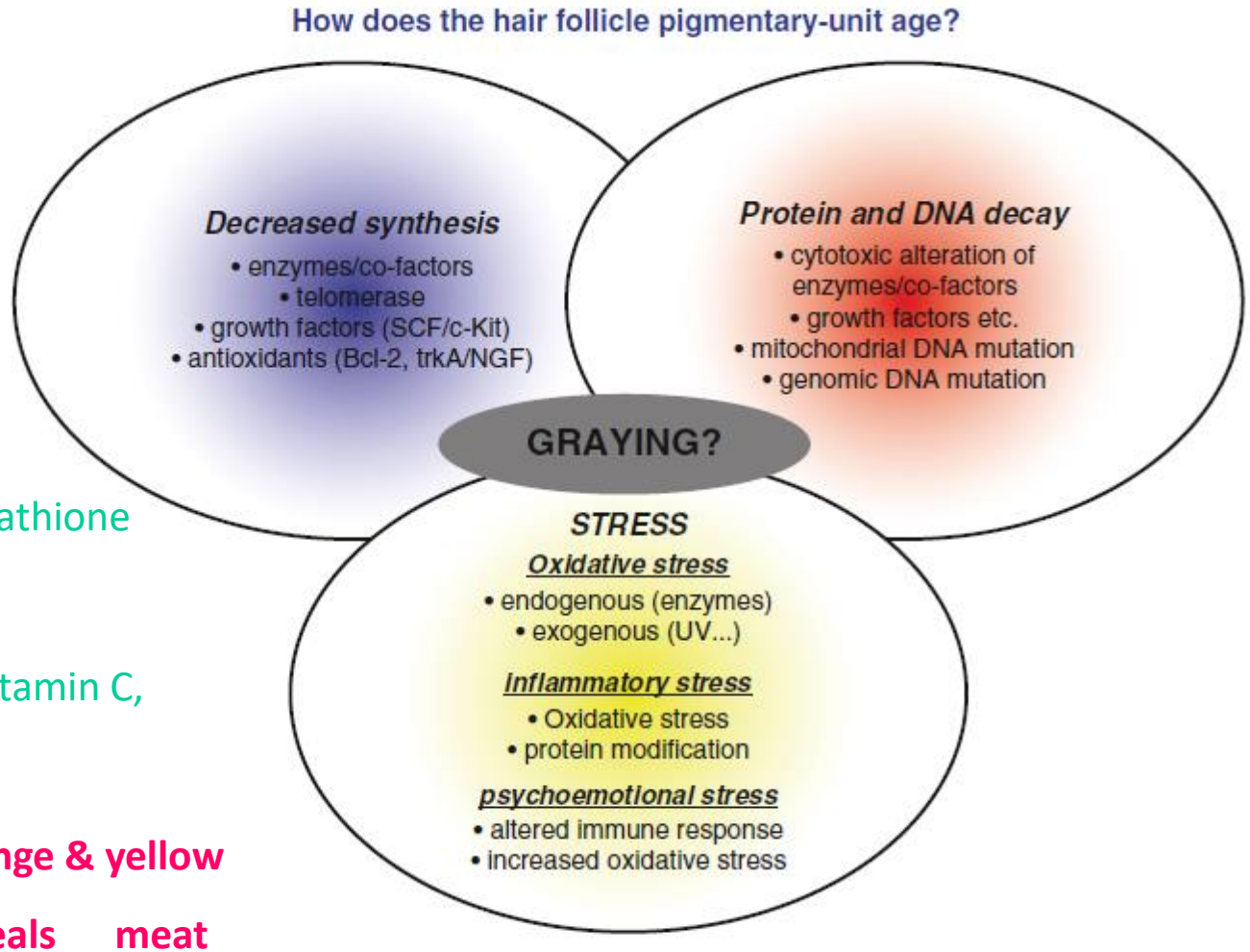
- H2O2-mediated **oxidation of methionine** in **tyrosinase enzyme** limits its functionality → leads to **gradual loss of hair color**.

- in **un-pigmented** & older follicles→ ↓expression **catalase** (the enzyme involved in cell response to **oxidative stress**)

- **hair graying** began @ ≈ age 40 years for both men & women, while the **extent of grayness** sharply ↑after the 5th decade regardless of onset age

- **Smoking** was found to correlate significantly with hair graying.

Fig. 10.4 Hypothetical scenario: Pathways interlinking in hair graying. Abbreviations: see Fig. 10.2



❑ The body possesses **endogenous defense** mechanisms:

- **antioxidant enzymes** (superoxide dismutase, catalase, glutathione peroxidase)
- **non-enzymatic antioxidative molecules** (e.g., vitamin E, vitamin C, glutathione, ubiquinone)

  ➢ Eating a **diet** → **rich in dark green vegetables** **orange & yellow fruits** **sprouted whole grains** **cereals** **meat** **soy** → helps maintain a **healthy follicle**

- **Anti-aging hair care** topical & ingestible products enriched with **vitamins, lipids, proteins, vegetable oils, & antioxidant** **rejuvenate** the **scalp** & **follicle,** & encourage new, more resilient **growth** from the root.

PROTECTION OF HAIR FROM AGING

❑ Scalp Care

- Beautiful hair comes from a **healthy scalp** ➔ taking care of the scalp is just as important as taking care of hair shaft.
  - **Hair problems** → **thinning** or **falling of hair**, **premature graying** or **breakage**, **dandruff,** & **flaking** → indicate an **unhealthy scalp**
- **Scalp care** should be chosen based on the **nature of your scalp**, whether it is **normal, oily, or dry**.
- **Normal scalp** has the right balance of **sebaceous glands** ➔ not prone to problems like **dandruff or excessive oil deposition**.

➢ Shampooing 3-4 times a week with a **normal shampoo** & a **light conditioner** will be sufficient for this type of scalp.

- A **warm oil treatment** & **massaging the scalp** 1-2 times / month → stimulates the oil gland & the massaging action improves **blood circulation**
  - **Coconut oil** → **triglyceride** of lauric acid (principal fatty acid)→ is great for **all hair types**.
  - has a high **affinity** for **hair proteins** because of its **low MW** & **straight linear chain**, is able to **penetrate** inside the **hair shaft**
  - is an excellent **conditioner** helps in the **re-growth** of **damaged hair** provides the **essential proteins** required for **nourishing** damaged hair **softens** the hair **conditions** the **scalp**.
  - **Jojoba oil & Avocado oil** is one of the most **emollient & moisturizing** oils & is particularly good for **really dry & frizzy hair**: nourishing, conditioning, & shine

- **Oily** scalp → the most prone to **dandruff & flaking**

- Such hair is usually **limp & flat**, making it almost **impossible for volumizing** or **styling products to hold**.

➢ Shampooing your hair **every day** with a **deep cleansing shampoo** is suitable for **oily hair**

- Have **dandruff** → choose an **anti-dandruff variety** Avoid using **leave-in conditioners**.

- A **dry scalp** causes constant **itching & flaking**, leaving the hair **rough, dull & frizzy.**

- oil secreted by the sebaceous glands is **insufficient** → apply **oil externally** & **massage** the scalp regularly to nourish the scalp.

- For **dry hair**:
  - shampoo **once or twice / week** with a product that contains **natural oils & moisturizing agents (ex,** Nutrium 10**)** is sufficient.
  - A thick **cream-based** conditioner & leave it on for ≈ 10 minutes before rinsing off makes hair **smooth & soft**.
  - Get a **warm oil treatment** every week to stimulate the sebaceous glands
  - Massage your scalp thoroughly to stimulate oil secretion.

- The regimen of **shampoo & conditioner together** is clinically proven to help restore **scalp's natural moisture** balance to create the right foundation for strong, beautiful hair from root to tip.

- Hair maintenance is an important part of healthy hair, but the **products** applied to the hair shafts have an equally **dramatic effect**.

❑ Hair Care

- Combing brushing shampooing → all **inflict damage** on the hair shaft that is **temporarily partially** reversed with **conditioners.**
- **hair cosmetics** may also be the cause of **hair loss** when **improperly** used or **used to excess**
- **Nourishment & proper grooming** is very important to keep the hair texture, growth, shine, & luster in a good condition.
- For **daily care** → choose **cleansing products** that are **gentle & moisturizing** preferably **without harsh surfactants** like SLS
- **Daily massaging of your hair** with your **fingertips** → helps proper **blood circulation** in the scalp.
- Apply **heat-styling products** to your hair **before blow-drying** try to keep the setting on **medium**, not **high**.
- Use **UV-protection hair products** or **wear a hat** if your hair is **brittle** or **color-treated**.
- Choose a **semi-permanent hair color product** for covering gray; it doesn't contain a**mmoni**a & has less H_2O_2.
  - This type of product may not be an option if you have a **lot of gray hair** (>50%) & want to cover it, in which case you'll need permanent color.

▪ **Elderly patients** →tend to wash their hair **less frequently** → can lead to **scalp problems**, such as seborrheic dermatitis, & especially, if the hair tends to be **greasy**, with a **flat & less full** appearance.

➢ **Frequent shampooing** is recommended → **fluffy** hair & give the illusion of **thicker hair.**

➢ The use of **conditioners** with every shampoo is recommended, as the conditioner leaves a **thin coating** on the hair shaft, providing a **shiny, healthy** look

the use of conditioner makes the hair **more manageable** **less susceptible** to further damage.

- A **deep protein conditioner** can be used **once weekly**, especially if the hair is **dry & longer > 10 cm**.

❑ Manipulate the Hair as Little as Possible

- There is a misnomer among **hair stylists** that **aging hair** requires more chemical processing & more manipulation 👎 → ☒ This is not true

  ↑**chemical processing** creates **more hair shaft damage**.

- There is no such thing as a "body re-storing permanent wave" or a "strengthening hair dye."
- Combing brushing curling teasing braiding also inflict **permanent hair damage**.
- **any manipulation of the hair shaft** → the possibility of **cuticular damage**, known as **"weathering" → chemical & physical** environmental insults on the hair shaft

➢ Comb the Hair Gently

- select a **comb** that ↓ hair breakage by **minimizing the friction** between the hair & the teeth of the comb ➔ a comb should have broadly spaced smooth teeth, preferably Teflon coated ⇒ ↓ combing friction.
- A comb with close rough edged teeth will grab the hair shafts→ ↑ the chance of hair **shaft fracture**, usually at the point where **cuticular scale** is most disrupted or completely absent.
- Combing friction is maximal when the **hair shafts are tangled** the most common reason for combing aging hair is to remove tangles.
- → the hair should be protected from situations where tangles arise, such as exposure to **wind or hair teasing**.
  - **Hair teasing** is performed by combing from the distal to proximal shaft against the direction of cuticle overlap.

➢ Select a Vented Ball Tipped Styling Brush

- The main criterion for brush selection is again **friction reduction**.
- **Closely spaced** natural bristle brushes are commonly selected by mature individuals, but this brush design ↑ **hair breakage**.
- A better option is to **select a brush design**, known as a blow-drying brush, for general grooming needs.
- These brushes possess **vents or openings** on the brush head to prevent heat from building up between the hair & the brush head, preventing **heat-induced denaturation** of the hair protein.
- **The widely spaced bristles** are also plastic & ball tipped to minimize friction.
- If drawing the brush across the **palm of the hand** causes **discomfort**, the brush is not recommended for use on aging hair.

➢ Avoid Combing Wet Hair

- Hair is more likely to **fracture wet** > **dry** ➔ gently de-tangle hair following shampooing from the **distal ends** to the **proximal ends** with the **fingers**, not attempting combing or brushing until the hair is **almost dry**.
- Many mature individuals feel that the hair must be **styled wet** to attain the desired style 👎→ This is only **partially true**.
- Hair will set in the position in which it is placed the instant that the last water molecule evaporates from the hair shaft ➔ the hair should be styled just before it is **completely dry** ➔ allow it to almost dry prior to styling to prevent hair breakage.

❑ Air dry Hair & Avoid Heated Appliances

- Any form of heat applied to the hair shaft (whether the source is a hair dryer, curling iron, or heated curlers) can **permanently damage the protein structure** of the hair.
- **Wet hair** has **water** on the **outside** of the hair shaft & water on **the inside** of the hair shaft to function as a **plasticizer**.
- **Hair dryers** attempt to speed evaporation of the water on the **outside** of the hair shaft & **heating styling appliances** attempt to **rearrange the water deformable bonds within** the hair shaft.
- When the hair is **rapidly** exposed to **high temperatures**, the water **within** the shaft turns to **steam** & exits the hair shaft by creating a loss of cuticular scale, known as **"bubble hair"** → the condition **is permanent** & bubble hair results in a **weakening of the mature hair shaft** & eventual **breakage**.
- Many mature patients who present with **hair loss** may be experiencing **hair breakage** due to **bubble hair**.
- Hair that has been **heat damaged** appears wavy & friable to the human eye & may possess a burned smell.
- → minimize damage by altering the **abrupt manner** in which the hair contacts heat.
- If the hair exposure to the heat is **gradual**, the damaging effect is not as great → a **gradual ↑temperature** is recommended ✓

- hair dryers can be safely used if the nozzle blowing out hot air is held **at least 12 in. from the hair**, allowing the **air to cool** prior to touching the hair shaft.
- Hair dryers also should be **started on low heat** to **initially warm** the hair prior to **drying** at **higher temperatures**.
- Heat hair **rollers & curling irons** can be used safely if allowed to **cool** before application to the hair.
- These thermostatically controlled devices tend to **slightly overheat**, which can induce **bubble hair** immediately on hair contact.
- Heated styling devices should be **unplugged for 1–2 min** prior to placing them in contact with the hair.
- If possible, the styling devices should be operated on a **low,** rather than **high**, temperature setting.
- If the device does not have multiple temperature settings, placing it in a **damp towel** can lower the temperature of the metal or plastic that contacts the hair.

➢ Avoid Scratching the Hair & Scalp

- It is not possible to scratch the scalp without scratching the hair ➔ an **itchy scalp** (either due to seborrheic dermatitis or postmenopausal itchy scalp) may result in **hair loss** due to **scratching-induced hair damage**.
- It is possible to remove all of **cuticular scale** from a hair shaft with only 45 min on continuous scratching with the fingernails.
- Most patients will not scratch their scalp continuously for 45 min, but the hair shaft effects of scratching are **additive** → 45 minutes can easily be accumulated if the patient scratches **5 min a day for 9 days.**
- ➔ it is important to **treat itchy scalp conditions** to preserve hair growth.

➢ Cut Away Damaged Hair Shafts

- If the hair shafts damaged by too much manipulation & chemical processing, no special shampoo or pricey conditioner can restore hair beauty.
- For these patients, the overall hair appearance can be improved by **removing 1–2 in.** from the distal hair shafts.
- This trims away split ends, formed when the missing cuticle exposes the softer internal cortex, & creates fresh hair ends that are **less frizzy**, more likely to maintain a **curl**, & less subject to **static electricity.**
- Trimming also eliminates the irregularity of broken hairs that creates the illusion of **fuller, healthier hair**.

- **Hair Sunscreens**
- **UVB sunscreen actives** in formulations → instant conditioners styling gels hair sprays shampoos
- They prevent **breakdown of keratin** due to sun exposure keep hair **dye** from **fading in UV light**
- This **topical approach** is **sub-optimal** because the sunscreen film is not **even on every hair shaft** & most sunscreens do not adhere well to the hair cuticle.
- Coating each & every hair shaft with sunscreen without making the hair appear **limp or greasy** is a **challenge**
- Ingredients like Crodasorb™ UV-HPP from Croda & PARSOL® SLX → prevention of **color fading** strengthening **hair body** enhancing **gloss** → when delivered through **hair color**, or hair care products, especially **leave-on sprays**
- **Enhancing Intrinsic Hair Photo-protection**
- **synthetic pigments** deposited on the **cuticle** & within the **cortex** via **hair dyes** →function as sunscreens.
- As **dark hair** has more photo-sensible proteins > **light hair**, ➔ show a greater **protein loss** > **light hair**.
- In **the cortex**, even though **dark hair** has more **photo-sensible proteins** > **light hair**, they also have **more melanin** to absorb the UV radiation.

Adjuvant Therapies for Telogen Effluvium

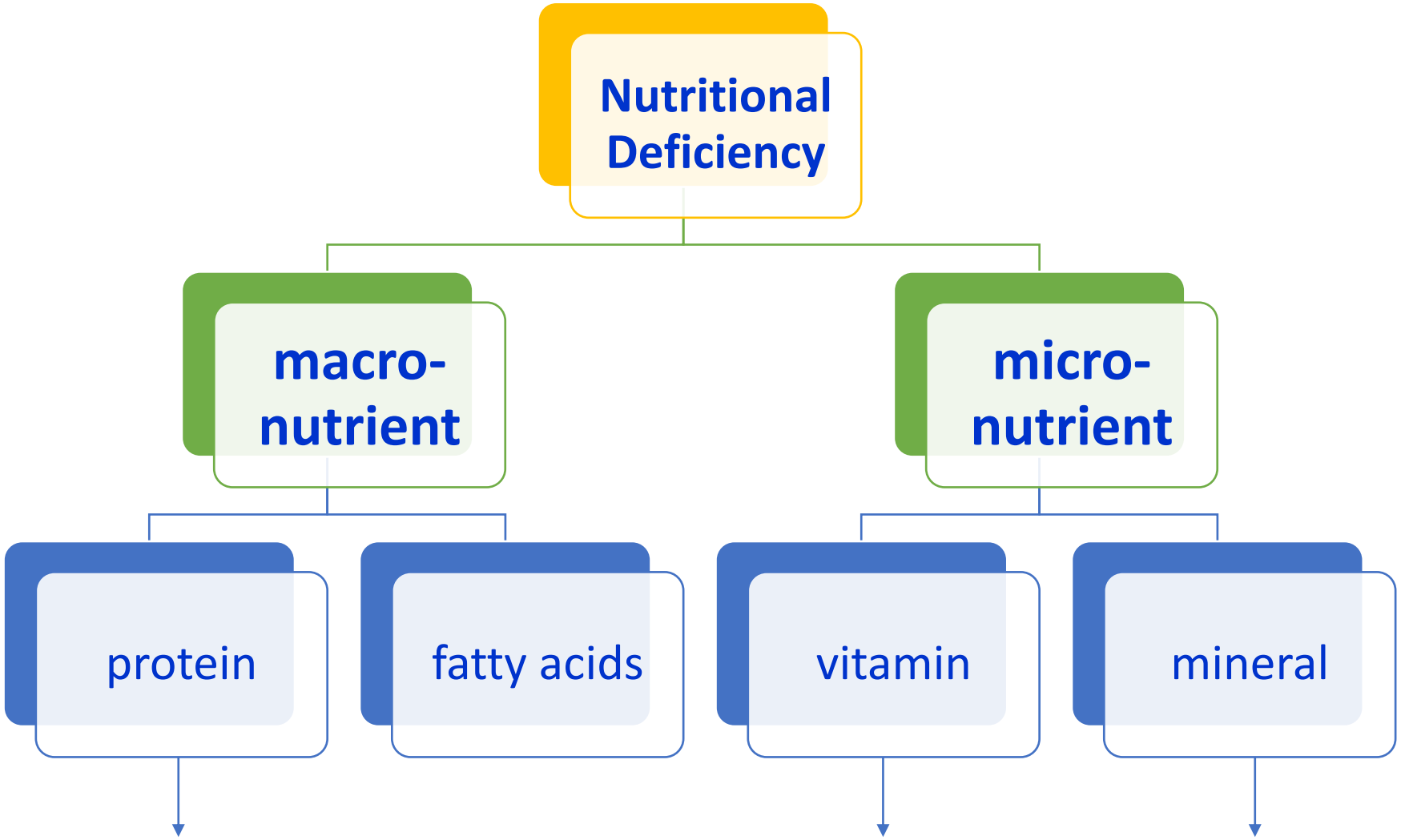
Minoxidil	5% Solution or Foam BID
Anti-seborrheic and anti-inflammatory	*Topical*
	Ketoconazole (2% shampoo 3 times weekly)
	Zinc pyrithione
	Selenium sulfide
	Ciclopirox olamine
	Corticosteroids
	Calcineurin inhibitors
	Oral
	Fluconazole 50 mg/day × 2 weeks
	Terbinafine 250 mg/day × 6 weeks
Amino acids	L-lysine (1.5 g daily with iron)
	L-cysteine (with medicinal yeast, pantothenic acid)
	Taurine
Camouflage	Wigs
	Extensions
	Tinted sprays/powders
	Keratin fibers
Surgical	Hair transplant
	Micropigmentation
Under study	Platelet-rich plasma
	Topical valproic acid
	Stem cell–derived proteins and cofactors

Botanical and "Natural" Treatments for Telogen Effluvium

Hair Promoters	Seborrheic Dermatitis Treatments
Asiasari	Sage
Proanthocyanidins	Rosemary
Ginko biloba	Thyme
Aloe	Garlic
Proteins	Walnut
Bergamot	Tea tree oil
Chinese herbs	
Ginseng	
Henna	
Hibiscus extract	
Hydrangea	
Illicium	
Sorphora	

Nutritional Deficiency

- **hair shaft** is composed almost entirely of **protein**→ protein component of diet is critical for the production of normal healthy hair.
- **The rate of mitosis** is sensitive to the **calorific value** of diet, provided mainly by **carbohydrates** stored as **glycogen** in the **outer hair root sheath** of the **follicle**.
- a sufficient supply of **vitamins** & **trace metals** is essential for the **biosynthetic** & **energetic metabolism** of the follicle.
- Mal-nutrition is due → **inadequate food intake** **food choices** that lead to **dietary deficiencies** **eliminate many foods or food groups** patients with **disordered eating habits** **illness** that causes ↑ **nutrient requirements** **systemic diseases:** hyper-thyroidism ↑ **nutrient loss** **poor nutrient absorption** Patients on **parenteral nutrition** → prone to micro-nutrient deficiency **prolonged breastfeeding:** ↑ nutritional requirements …
- Nutritional deficiencies may induce **structural** **pigmentary abnormalities** **TE**
  - TE → **rapid weight loss** **negative nitrogen balance** (ketosis), as seen in patients on **very low carbohydrate diets**.
- Nutritional inadequacy in the **elderly**: **anorexia of aging**
- with age, the **needs** for types & quantities of nutrients may change.


Nutritional Deficiency
macro-nutrient
micro-nutrient
protein
fatty acids
vitamin
mineral
L-Carnitine
l-cystine
L-lysine
taurine
Vitamin A, D
Vitamin B3 (Niacin), B5 (pantothenic acid), B6 (Pyridoxine), Biotin (Vitamin H), B12
Vitamin C, E
Fe
Zinc
Selenium
Copper

Micronutrient Deficiencies Implicated in Telogen Effluvium

Nutrient	Risk Factors	Signs and Symptoms	Repletion Dose	Maintenance Intake
Iron	Blood loss (menorrhagia, GI); vegetarian or restricted diet	Glossitis, cheilitis, koilonychia. anemia: fatigue, pallor, tachycardia	50–60 mg PO elemental Fe (325mg ferrous sulfate) BID × 3 months	18 mg (women 19–50 y) 8 mg (men)
Zinc	Parenteral nutrition, ACE-I treatment, malnutrition; systemic disease including gastritis and colitis	Brittle and depigmented hair, nail dystrophy, acral and perioral dermatitis, cheilitis, blepharoconjunctivitis, diarrhea, neurologic sequelae, poor growth	25–50 mg/day elemental zinc (adults) 0.5–1 mg/kg/day elemental zinc (children)	11 mg/day (men, lactating/pregnant women) 8 mg/day (women)
Biotin	Parenteral nutrition, treatment with antibiotics or antiepileptics, avidin consumption	Trichodystrophy, nail dystrophy, perioral dermatitis, conjunctivitis, infections	1–5 mg/day (biotin-deficient adults) 3–5 mg/day (alopecia patients)	0.3 mg/day (adult) 0.05–0.3 mg/day (children)
Vitamin D3	Increased age, obesity, lack of sun exposure, dark skin tone, sunscreen use, inflammatory bowel disease, fat malabsorption	Rickets, osteomalacia, osteoporosis; potential role in other systemic diseases	50,000 IU weekly × 12 weeks	1000–2000 IU daily

Note: ACE-I, angiotensin converting enzyme inhibitor, BID, twice daily; IU, international units.

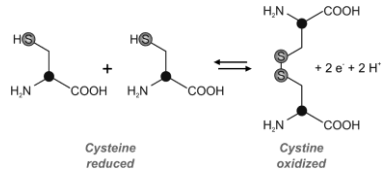
Telogen Effluvium: Laboratory Evaluation

Basic	Extended
Complete blood count	Screen for excess androgen
Comprehensive metabolic panel	Others, dependent on personal and family history
Ferritin	Hair clipping
Thyroid stimulating hormone; + T4 test?; + antimicrosomal thyroid antibody test?	
Zinc	

❑ Protein

- **hair fibers** are primarily composed of **protein (keratin)** ➔ **impaired hair growth** is one of the first signs of **inadequate intake**, & may occur even prior to ↓ **serum albumin levels**.
- patients with **inadequate calorie intake** those on **restrictive diets** (**vegans & vegetarians**) in GI disease blood loss …
- ➔ **protein supplements** & **supportive calories** may improve the **quality of hair** & **promote growth**.

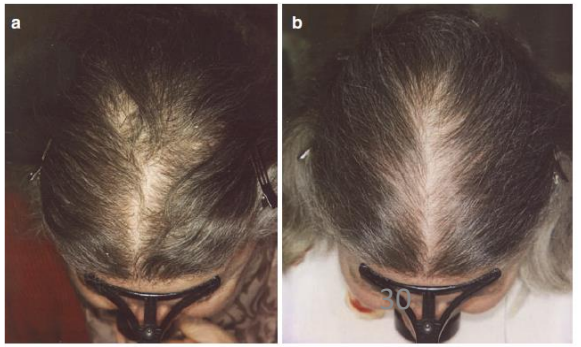
❑ *Amino Acids*



- **l-cystine** (a constituent of **keratin**) for treatment of **hair loss** ➔ formed from **cystine**

(the limiting factor in the **biosynthesis** of the natural **antioxidant glutathione**)

- **B6** ➔ **l-cystine incorporation** into hair cells
- dietary supplements containing **l-cystine + B-complex vitamins** **or** **medicinal yeast** (is rich in **B-complex vitamins**. pantothenic acid)
- **L-lysine** ➔ in **iron & zinc** uptake & absorption ➔ **L-lysine + iron** ➔ treating CTE.
  - ➔ ↑ serum **ferritin levels** & ↓ % of hairs in the **telogen phase**



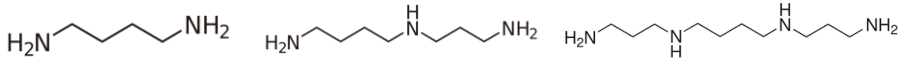
Supplementation with **cystine & vitamin B-complex**:
(**a**) before
(**b**) after 6 months of oral therapy

- a **faster** normalisation of the **anagen/telogen ratio** when this supplement **combined with minoxidil** topical solution ↔ minoxidil **alone**
- minoxidil → ↑ the incorporation of **thymidine** (as a marker of **cell division**) ↑ **uptake of cysteine** by the **hair follicle**
  - **regressive alopecias**: **female pattern** hair loss **senescent** alopecia → progressive **shortening of the anagen phase** & **miniaturization of the hair follicle** → agent which impact **hair count, hair density, & cumulative hair shaft diameter**✓, ex, **minoxidil**

- The amino acid **taurine** → **promote follicle cell survival**
  - An **oral supplement** containing taurine, zinc, & catechins is promoted to **prevent hair mass loss**.
- **l-carnitine (**a tri-methylated AA-derivative)
- can be obtained **naturally** from **dietary sources**: red meat nuts seeds vegetables fruits or **synthesized** from **lysine & methionine** within our bodies.
- hair proliferation is an **energy-consuming process** Owing to its function in **energy metabolism** → involved in the **hair re-generation cycle** promote **hair shaft elongation** by stimulating the **proliferation** of **matrix keratinocytes** **protecting** them from **apoptosis** both of which **prolong anagen duration**
- **oral supplementation** with **l-cystine, l-methionine, pantothenic acid, thiamine nitrate, & medicinal yeast** → ↑ **the anagen rate** in apparently healthy women with **TE** of **unknown nature**

- **Amino acid-like L-Arginine** is a **nitric oxide precursor** → stimulate hair **re-growth** by **stimulating** the **production** of **hair follicles** **strengthen** hair by **nourishing** the hair roots

- **Poly-amines** including putrescine, spermidine, & spermine are **poly cationic aliphatic amines** synthesized from **l-arginine** or **l-methionine**



➢ The maintenance of **anagen phase** by **antagonizing apoptosis** in **matrix keratinocytes**

- They can be obtained by:
  - **endogenous biosynthesis** through **ornithine decarboxylase (ODC)**
    - ❖ **excessive facial hair growth** in women can be **ameliorated** by the application of eflornithine, or di-fluoro methyl ornithine (DFMO), a compound that **inhibits ODC**
  - **exogenous supplementation** → fruit vegetables food of **animal** origin **fermented** food products

❑ Marine Proteins

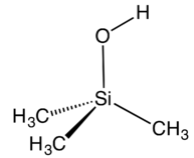
- A blend of **shark & mollusc powder** has been used to **promote hair growth.**
- marine protein supplement + silica, vitamin C, biotin, & zinc did also improve **hair counts** & ↓ **hair shedding** →in **women** with self-perceived **hair thinning** due to poor diet stress hormonal influences abnormal menstrual cycles

❑ Soy

- Soy is a nutrient that supplies **non-animal protein & amino acids** other ingredients including the isoflavones: **genistein** **daidzein** **equol** contains fiber copper, zinc, calcium, magnesium, iron saponins B vitamins omega-3 fatty acids phyto-estrogens: to some extent, substitute for **post-menopausal** women's **endogenous estrogen.**
- It may promote "good **breast & prostate** health."
- Its usefulness in **senile** or **androgenetic alopecia** is not known…?
- Many beneficial claims of the **anti-androgenic effects** of soy are attributed to genistein **An anti-androgenic** effect of equol, a metabolite of the soy phyto-estrogen daidzein

❑ Protein Hydrolysates

- **disulfide bond** give hair its **strength** through molecular **cross-linking** the **side groups**: HBs salt linkages hydrophobic interactions
- **the addition of proteins to hair** would allow them to interact with the **proteins of the hair** through similar chemical bonds…
- → to provide a **re-structuring** of the **damaged proteins** & to help **bring back the condition of the hair** to its natural state.
- **plant** or **animal sources...**
- proteins are proven to→ ↑ the hair's tensile strength elasticity body softness repair of split ends & cuticular damage protect against insulting treatments such as **detergents & chemical treatments**.
- **processing & chemical modification** prior to their addition to a hair or skin care product…
  - Ex, the **hydrolysis** of the **peptide bond** with either an **alkali or enzyme** to→ ↓ **MW**, primarily done to ↑ **water solubility.**
    - absorb into the **interior of the hair** on **its surface**
    - they then can interact with the **fibrous proteins of the hair** with the same bonds that are found both on an intra- & inter-molecular basis of the native proteins.
  - **Functional groups** added to proteins → ↑ **their interaction with hair** as well as **their performance**



    - Ex, **quaternization** for hair conditioning, & reaction with a **silanol group** ➔ the **conformational** & **chemical** variations that proteins can assume are quite large. → derivatized such as with **quaternization** → ↓ the **loss of tensile strength** caused by **anionic surfactants**.
- Proteins have been formulated into **rinse-off** & **leave-in hair** products

❑ Keratin Biopolymer

- • It protects the hair's natural protein by providing **preferential binding sites** & **degradation sites** for **aggressive influences**.
- The protected **cystine groups** present in the **keratin biopolymer** provide a **site for reactivity.**
- The biopolymer components **acting** on the **surface of the fiber** provide a **shielding** effect.
- • It provides **antioxidant activity** against aggressive influences.
- keratin biopolymer is a purified form of keratin intermediate filament protein (IFP)
  - This purified form is manufactured solely from **wool of New Zealand origin.**
  - This material is predominantly **intact protein**
  - it has not been degraded in any form
  - it retains both its **original size** (MW~55 kD) & AA composition.
  - It also contains a smaller amount of **peptide** (average MW 3–4 kD)

→ has excellent **film-forming** properties

→ is capable of **penetrating** the **cortex** of the hair fiber

Table 1. Amino acid profile of the keratin biopolymer

	Mole (%)
Aspartate	7.9
Glutamate	15.3
Serine	11.0
Glycine	8.2
Histidine	0.9
Arginine	7.7
Threonine	6.5
Alanine	7.5
Proline	5.5
Tyrosine	1.1
Valine	6.5
Methionine	0.2
Lanthionine	0.2
Isoleucine	3.6
Leucine	8.7
Phenylalanine	2.4
Lysine	2.1
Cystine	4.3

❑ Essential Fatty Acids

- The essential fatty acids, linoleic & α-linoleic acid are necessary for **normal human metabolism**.
- FA deficiency → by inadequate diet chronic illness, malabsorption biliary atresia cystic fibrosis
- **Dermatologic signs** → dermatitis **TE** of the **scalp & eyebrows** de-pigmentation
- **Cutaneous** manifestations → severe **dryness & scaling** of **skin** **redness & scaling** of **scalp & eyebrows** weeping inter-triginous lesions the **hair** becoming **dry** **unruly** **lighter in color** a significant **telogen hair shedding**
- Foods & supplements rich in fatty acids & supplements → **reverse diffuse alopecia**.
- → a trial of **an essential FA supplement** in TE patients with **chronic scalp scaling** unresponsive to **topical treatment**, particularly if the individual's diet is **low in fish oil** or **red meat**

❑ Repair of the Surface Lipid Layer

- **The F layer** located on the periphery of the hair surface → is important for many cosmetic attributes such as shine, combing, feel, & overall manageability.
- **Rinse-out conditioners** are then utilized that deposit a layer of **cationic surfactant**, such as behen tri-methyl ammonium chloride in combination with fatty alcohols, to restore this **hydrophobic layer** & its resultant cosmetic effects.
- However, this is **temporary** since this layer is easily **removed** during the **shampooing** process, with the result that the hair reverts back to its **damaged state**.
- ➔ provide a **more permanent hydrophobic layer** on the surface of hair that will maintain hair health despite the weathering & damaging treatments that hair is subjected to.
- → depositing a complex of **18-MEA** in combination with **stearoxy propyl di-methyl amine (SPDA)**
- Another factor in producing a persistent hydrophobicity is the **fluid-like nature** at the upper region of the lipid film caused by the **anteiso branching** of the 18 MEA molecule → fluid character imparts a **greater molecular mobility** that contributes to the persistent nature of the film after shampoo washing

❑ *Retinoids*

- Homeostasis of vitamin A metabolism & maintaining a precise level of retinoic acid (RA) → essential for an optimal function of the **pilosebaceous unit**
- **All-*trans* RA (atRA)** can alter **stem cell regulation** of the **hair cycle** at both **telogen-anagen** & **anagen-catagen** transitions.
- ↓ **RA signaling** & an excess of **retinol & atRA** within the **basal epidermis** & **outer root sheath** both lead to → progressive **alopecia**
  - Blocking **RA signaling**→ delays **anagen initiation**
  - ↑ the levels of **retinol & atRA** → **accelerates** the transition from **telogen** → **anagen.**
  - Exogenous atRA → ↑ **catagen phase** excess RA → ↓ the **# & length** of **hair follicles** (in vitro)
- **topical use** of retinoids → anti-aging effect on the **skin** its potential application in **counteracting hair aging** …?
- the potential of using retinoids, rexinoids (RXR-selected ligands), & VDR-selected ligands for promoting **hair growth.**

❑ Vitamin A

- Vitamin A plays an essential role in **cell maturation** & **differentiation** **the immune system**
- **Vitamin A deficiency** is not an established cause of **hair loss** although may theoretically **affect vitamin D metabolism**.
- **Excessive vitamin A intake** in patients treated with **systemic retinoids**, such as **isotretinoin** or bexarotene→ can cause TE & xerosis.
- The recommended **upper limit** of **tolerable intake** of vitamin A→ < 2000 IU/day for **children** **<10,000 IU/day** for **adults**, including **pregnant & lactating** females.

❑ Vitamin D

✓ an **optimal** [vitamin D] → **delay** the **aging** process, including **hair loss**

- Hyper-vitaminosis D a complete or partial **lack** of vitamin D **receptor** (VDR) → **premature aging**

- The **human hair follicle** possesses a **vitamin D receptor (VDR)** in the **external root sheath**.
- **the VDR** (independent of the vitamin D3 hormone) plays an important role in the **hair follicle cycle**, specifically in **anagen initiation**
- The follicular VDR is adjacent to the **anagen bulb**, which is integral in **follicular re-generation**

- **Genetic factors** also appear to play a pivotal role in vitamin D **absorption**.
- **low levels** of serum vitamin D3 → adversely **alter follicular cycling & produce TE.**
- Vitamin D3 **supplementation** → **initiate hair follicle cycling** **stimulate hair growth**
- ➔ recommend monitoring serum vitamin D3 in TE patients & advising supplementation in those who are deficient.

👎 **Topical calcipotriol** has not been shown effective in treating TE.

- Patients with **darker skin tone** ↓ vitamin D **intake** or **absorption** limited **sun exposure** are **at risk**.
- **daily supplementation** with >1000 IU of vitamin D3 & calcium.
- **vitamin D deficiency:** <20 ng/mL (50 nmol/L)- 30 ng/ mL (75 nmol/L) ➔ repletion regimen: **50,000 IU** of vitamin D3 **weekly for 12 W**
- Vitamin **D2** is an alternative, but is not as **well absorbed** as vitamin D3.
- Vitamin D3 levels should be **re-checked** following repletion to ensure **response to treatment**.
- **maintenance supplementation** with **1000 - 2000 IU** of vitamin D3 **daily** for patients with a history of **low or borderline** vitamin D.
- patients should be advised to take supplements with the **largest meal of the day**.

❑ *Vitamin C / Ascorbic acid*

- Vitamin C is not synthesized in the human body ➔ dietary intake is essential.
- The recommended dietary allowance for adults is **60 mg/day**.
- Vitamin C deficiency (*scurvy)* in **alcoholics** **elderly living alone** Patients with **chronic disease**: cancer chronic renal failure
- **The follicular changes** are a direct consequence of → ↓ **cross-linkage of hair keratin** resulting from ↓ **# of reduced disulfide bonds** & **curling of follicles** resulting from altered **peri-follicular connective tissue**.

❑ **vitamin B3 /*Niacin***

- Pellagra (from: "pelle agro"= rough **skin**) results from a deficiency of **the B vitamins**, most notably niacin
- It occurs endemically in → areas where **maize & millet** form the main diet (Asia, Africa, India) in individuals with **inadequate dietary intake** (**alcoholics**, **anorexia nervosa**) impaired **absorption** of niacin (**Crohn's disease**) **drugs** that **interfere** with niacin **metabolism** (INH) **tumors** that interfere with niacin **metabolism** (carcinoid)
- Niacin is an essential component of **NADH** that connects the **citric acid cycle** to the process of oxidative phosphorylation important for the generation of **ATP** ➔ energy supply.
- The recommended daily intake is 6.6 mg/1,000 kcal, & at least 13 mg/day.

❑ Biotin (Vitamin H)

- Biotin is an essential co-factor for **mitochondrial carboxylase activity** & is required for **normal hair & nail structure**.
- Biotin deficiency is **rare**, as daily requirements are **low** & it is both absorbed from **the diet** & produced by **intestinal bacteria**.
- **Deficiency** → **altered intestinal flora** (**antibiotic** treatment) excessive ingestion of **raw egg white** (containing avidin that binds biotin) congenital or acquired biotinidase or carboxylase deficiency patients receiving **parenteral nutrition** or **antibiotics** (which impair normal GI flora) Certain **anti-epileptic medications**
- Symptoms of biotin deficiency are→ **alopecia** + **peri-orificial dermatitis** perioral dermatitis **blepharon-conjunctivitis** **recurrent infections** **hair shaft abnormalities**: trichorrhexis nodosa onchodystrophy **TE** *however the primary effect of biotin deficiency on the hair is **tricho-dystrophy.**

- Biotin supplementation is rapidly **metabolized & excreted**→ has low toxicity potential.
- **biotin supplementation** in patients with **normal serum levels** can reverse TE…?
- Supplementation in adults has not been documented to **improve alopecia**. however it may **strengthen hair & nail structure**.
- US RDA daily dosing in **children & infants** is 0.05 to 0.3 mg/day in **adults** is 0.3 mg/day In **biotin deficient adults**, 1 - 5 mg
- The common recommendation for treatment in the **alopecic disorders** is biotin 3 - 5 mg/day.

❑ **Pantothenic Acid** (vitamin B5)

- is a naturally-occurring vitamin found in beans peas meat poultry fish whole-grain cereal.
- is necessary for **normal metabolism** it has no recommended daily allowance (RDA) **no problems** have been found that are caused by **B5 deficiency**
- Lack of pantothenic acid is **exceedingly rare**, & may be associated with a lack of **other B vitamins**, intestinal **malabsorption**, & severe lifet hreatening **malnutrition**
- Its **utility for hair growth** has not been reported in the literature.
- **Topical compounds** may include **panthenol** (a synonym of pantothenic acid) but have not shown efficacy.

👎 **contact urticaria & contact dermatitis** from it use.

❑ **Pyridoxine (vitamin B6)**

- is required for **utilization of energy** in **ingested nutrients** production of **RBCs** proper functioning of the **nervous system**
- vitamin B6 deficiency resulting from poor diet certain medications some medical conditions
- There are no studies that indicate B6 suppplementation improves or reverses **alopecia**…?

❑ ***Vitamin B12***

- Deficiency ***(Pernicious Anemia)*** in → strict **vegetarianism** **celiac disease** stagnant **bowel syndrome** **pancreatic disease** with **steatorrhea** ingestion of **fish tapeworm** **atrophic gastritis** with **antibodies to intrinsic factor** (pernicious anemia).
- Clinical manifestations are: megaloblastic anemia peripheral neuropathy degeneration of the posterior & lateral **spinal cord**.
- The recommended daily intake of vitamin B12 is **3 mg**.

❑ Iron

- **Iron & zinc** d**eficiency** are also 2 common nutritional causes of **chronic telogen effluvium**
- the most common **causes** of **iron deficiency** → menstrual blood loss pregnancy lactation in **pre-menopausal women**

  in **post-menopausal women:** ↓ **absorption** **GI bleeding** ***Low iron stores** are **rare in men**
- **Total body iron** is distributed among **storage iron** **transport iron** **functional iron**
  - **Storage iron** is the body's iron reserves that are **tissue bound** & measured by serum [ferritin]
  - **transport iron** is transported to the tissues & measured by [transferrin] & saturation
  - **functional iron** consists of iron that is **bound** to hemoglobin, myoglobin, & diverse enzymes → measured by [Hb]
- **Serum iron levels** → an inadequate reflection of **iron stores** in the body.
- **Iron deficiency** → ranging from **iron depletion** to **iron deficiency anemia**.
  - In the former, body **iron stores** are ↓, but **functional & transport iron** remain normal, leaving little reserves if the body requires more iron
    - occur in the absence of iron deficiency anemia & has been associated with **TE.**
      - patients who had **low** serum ferritin levels → treated with **oral iron** &/or **L-lysine** daily
  - in the latter, **storage, transport, & functional** iron are severely ↓ & can lead to impaired function of **multiple organ sites**.

- in **female patients** with **alopecia areata**, mean serum **ferritin levels** were significantly < those of controls.
    - correlation between the **age of women** & **serum ferritin levels**: younger (menstruating) women having **lower ferritin levels.**
- The **symptoms** of **iron deficiency**→ fatigue & ↓ exercise tolerance signs of **severe anemia** → skin & conjunctival pallor tachycardia low blood pressure **dermatologic findings**→ hair loss (TE) cheilosis koilonychia (Fig.)

Fig. 15.7 Clue to iron deficiency: koilonychia

❖ some patients with iron deficiency & even anemia may remain completely **asymptomatic**.

- the recommendation of iron supplementation for **women** with **hair loss** & serum ferritin levels within the normal limits
- To correct **iron deficiency** → **ferrous fumarate, -lactate, -gluconate, or -sulfate** should be taken for **several weeks** in doses of **100 mg (elemental iron)** or **2 daily doses of 50 mg**, as absorption is lower in high doses ✓: better tolerated.
    - **3 times daily** dosing → improve absorption, but may ↓ compliance.

❖ Adverse GI effects → **minimized** by **gradual ↑ of dosing** to therapeutic levels intake **with a meal** a **high-fiber diet**

- **The daily reference intake** of iron is **8 mg** for **men** **18 mg** for **women** between 19 & 50 years of age.
- **healthy** adults ≥18 years should <u>not</u> consume > **45 mg** of iron / day → **iron overload** may result in **tissue damage & fibrosis**
- → recommend a **ferritin level** of at least 70 µg/L (reference range 9–300 µg/L) for **female TE patients**.
    - → the favorable risk-to-benefit ratio of supplementation at this level.

❖ **Ferritin** & **hemoglobin** should be checked again after **3 months** → until Hb is normalized & a ferritin level of 70 µg/L is achieved (reference range: 9–300 µg/L) **Maintenance monitoring** should be continued **every 6 months**

- do not recommend iron supplementation in **the absence of anemia**.
- **The role of iron supplementation** in **non-anemic TE patients** ...?
- Administration with **500 mg of vitamin C** or **1000 mg of lysine** will ↑ absorption.
- **Oral iron** & **L-lysine supplementation** → ↓ **anagen** → **telogen** transition of hairs ⇒↓ shedding.
- **sufficient intake of red meat clams fish.**
- **Non-heme iron sources** such as **beans peas cereals** should be eaten together with **sources of vitamin C.**
- Excessive consumption of **coffee & tea** should be avoided, as they inhibit iron absorbtion.
- If deficiency is severe, **parenteral iron supplementation**

❑ Zinc

- Zinc is essential to hair cycle regulation & normal hair growth
- First, zinc is an important **cofactor** in the action of >300 **metalo-enzymes** involved in **hair growth**.
- Zinc →**inhibit** apoptosis-related endonucleases which **promote** follicular transition from **anagen** → **catagen**.
- zinc is an integral component of **zinc finger transcription factors** which **regulate hair growth** through hedgehog signaling.
- zinc is essential to **immuno-modulation** at the level of the **hair follicle** → implicates zinc deficiency in AA.
- **Zinc deficiency** is not seen in normal healthy individuals.
- **Alkaline phosphatase** is a zinc-dependent enzyme, & ↓ levels are a clue to **diagnosis**.
- It may occur in autosomal-recessive acrodermatitis enteropathica in patients taking **drugs** that **chelate zinc** such as **ACE-inhibitors** **alcoholism** pancreatitis malabsorption hemodialysis sickle cell anemia **parenteral nutrition** after GI bypass surgery **Helicobacter pylori infection** excessive **iron supplementation** prolonged **breastfeeding** without supplementation
- **Symptoms of zinc deficiency** (acrodermatitis enteropathica) → TE thinning depigmentation brittleness of the hair onychodystrophy acral & perioral dermatitis cheilitis blepharon conjunctivitis ↑rate of infection diarrhea neurologic sequelae growth retardation.

- The **daily reference intake** for **male adults** & **pregnant women** is 11 mg for **females** 8 mg.
- **In deficiency**, the recommended dose for **adults** is 25 to 50 mg of elemental zinc 0.5 to 1 mg/kg for **children.**

❖ individuals who take ≥ 30 mg zinc / day can become **deficient in copper** **Copper deficiency** can in turn lead to **hair loss.**

- **supra-therapeutic levels** resulting from **over supplementation** → hair loss as well as **copper, iron, & calcium deficiency** GI side effects headache drowsiness
- The **topical application** of zinc in the form of zinc pyrithione shampoos → nominal improvement in **androgenetic alopecia** as compared with male patients treated with **5% topical minoxidil solution**.
- **Supplementation** has not been shown to **reverse TE** in the absence of established deficiency
- Foods rich in zinc include → shellfish legumes nuts whole grains green leafy vegetables

❑ *Selenium*

- **Selenium** → an important component of the **antioxidant defense mechanism**→ essential component of the antioxidant enzyme **glutathione peroxidase**
- is necessary for proper **keratinocyte function** & **skin development**

➢ both an **excess & a deficiency** of selenium results in **alopecia** leading to **apoptosis** induction in **keratinocytes.**

- Selenium is an essential mineral required for the **formation of seleno-proteins**
- Selenium is **covalently** bound to **cysteine → substituting sulfur** in the **sulfhydryl (-SH) groups**.

👎 **overdose** from **environmental sources** such as some plants, soil, mining, or crude oil (selenosis) → cause **severe toxicity** & **hair loss**

- **selenium deficiency** in low-selenium regions or parenteral nutrition can lead to **alopecia** & **albinism**.
- Clinical manifestations of selenium deficiency → cardiomyopathy muscle pain weakness with an elevation of transaminase creatin kinase levels **Cutaneous manifestations: white nails** & **hypo-pigmentation** of skin & hair (pseudoalbinism).
- The range between selenium **deficiency & toxic overdose** is **small**, & the risks of selenium supplementation are controversially discussed…?
- The recommended daily dietary allowance for adults is 55 µg/day.

❑ Copper

- Copper is a trace metal that has not been associated with **hair growth** or **hair loss**.
- **Zinc** & other trace elements: **copper** & **selenium** → required for the synthesis & activation of **thyroid hormones** ➔ their deficiency → **hypo-thyroidism**
- **thyroid hormones** are essential for the absorption of **zinc** ➔ hypo-thyroidism can result in **acquired zinc deficiency**
- possible **antioxidant effects** in scavenging for radicals in the body possible anti-cancer effects **in hair** is essential for the **oxidation of thiol** groups to **di-thio crosslinks** essential for **resilient properties** of **keratin fibers**.

👎 **high levels of copper** may be linked to **liver & brain tumors**.

- copper blood levels do not necessarily reflect **tissue levels** accurately.
- no significant differences except for **copper content** in serum of subtypes of patients with **alopecia areata**.
- intake of **copper** is not known to **induce hair growth**…?
- Dietary deficiency in humans is **rare** → A diet containing **2–3 mg** of copper / day is sufficient.
- **Copper deficiency** → in **premature babies** severely **malnourished children** with inadequately supplemented **parenteral alimentation** with **prolonged oral zinc therapy**.
- **Clinical manifestations** of **acquired copper deficiency** : microcytic **anemia** **leucopenia** **myelopathy** **hypo-pigmentation** of **hair**

Devices & Other Procedures

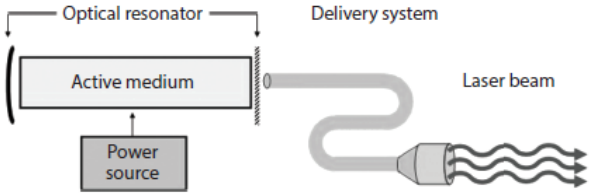


FIGURE 18.1 Components of a laser.

❑ Low-Level Light Therapy (LLLT)

- **Laser sources** guarantee **hair growth** & are available without prescription → **↑ blood flow @ the dermal papilla**
- **improve hair growth** through **photo-bio-stimulation** → employ "low-intensity laser light" of different λs.
- The HairMAX LaserComb® uses a **laser diode** of the **red portion of the visible light spectrum** @ λ= 655-nm

- Treatment protocols include→ **15–30 min treatments** on alternating days for 2–4 weeks, tapering to 1–2 treatments/week for 6–12 months, followed by biweekly or monthly maintenance treatments.
- a change in the **texture & quality** of hair in patients using laser comb devices even if there is no **detectable regrowth**
- Low-level laser sources appear to be **safe** in the treatment of hair loss **Side effects** included parasthesias & urticaria.
- It has the **advantage** of home use & parting the hair → reaching the scalp
- a certain effect in patients with **mild androgenetic alopecia**
- LLLT stimulates **telogen** hair follicles into **anagen** via→ **alteration of oxidative metabolism** in the mitochondria ↑ ATP stimulation of transcription factors modulation of ROSs induction of transcription factors.

- **HairMax** released the HairMax LaserBand
- Helmet-like LLLT devices known as the TOPHAT655 unit or the iGrow® Hair Growth System (Apira Science, Inc., Boca Raton, FL, USA)
- Males & female subjects treated with this 655-nm device → ≈ 37% ↑hair growth
- The Capillus272® is a cap-like LLLT hands-free home device → for androgenetic alopecia → used for 30 minutes every other day.
- Capillus272® Office Pro Theradome® Lasercap®

- (a) HairMax Laser-Comb Dual 12: baseline in a 26-year-old female
- (b) after treatment for 8 minutes at each session, 3 times weekly for 26 weeks.
- (c) iGrow Hair Growth System (TOPHAT655): baseline in a 20-year-old male who was experiencing early thinning in the crown area
- (d) after treatment for 4 months for 25 minutes every other day.
- (e) Capillus 272: baseline in a 54-year-old female;
- (f) after treatment for 30 minutes every other day for 3 months.

❑ Platelet-Rich Plasma

- α granules of platelets contain **several growth factors** such as platelet-derived growth factor (PDGF) transforming growth factor-b (TGF-b) vascular endothelial growth factor (VEGF) other proteins...
- Possible **mechanisms of action** → ↑ levels of the **anti-apoptotic** protein Bcl-2 protecting cells from **apoptosis** an upregulation of **b-catenin** leading to→ the formation of **hair epithelium** & the **differentiation of SCs** into **hair follicle cells** ↑ expression of **fibroblast growth factor-7** followed by a **prolongation** of the **anagen phase** of the hair cycle.
- limited data regarding optimum preparation, treatment regimen, & efficacy are available…?
- ↑ hair growth →in pattern hair loss a significant effect in **alopecia areata** in **androgenetic alopecia**

❑ Mesotherapy

- The injection of certain ingredients → vitamins plant extracts even **finasterid** or **minoxidil** → into the **dermis** & **subcutis**
- However, there are no studies regarding the **safety & efficacy** of this treatment.

❑ Microneedling

- Micro-needling with or without **minoxidil** topical solution is sometimes performed.
- Although some reports claim efficacy, the risk of **hair breakage** & **scarring** should be kept in mind.
- Minoxidil has been shown to penetrate predominantly through the follicular openings.

❑ **Camouflage** & Scalp **Micro-pigmentation**

- the use of **small colored keratin fibers** (powders, sprays) to cover thinning areas **the (semi)permanent tatooing of the scalp** may look unnatural with progressive **hair loss.**
- No long-term experience exists regarding **color changes**.
- This method may be considered to **cover scars**, in addition to hair transplantation, or in women with progressive thinning.
- It should not be used in alopecia areata, or in scalp areas of men with progressive androgenetic alopecia.

❑ **Mind-Altering** Approaches

- The clinical existence of **neuro-cutaneous pathways** is routinely reaffirmed in **dermatological patients**
- Patients with eczema, psoriasis, lichen simplex chronicus, acne, & alopecia areata commonly correlate a flare of their disorder ↔ ↑ **stress** in their lives.
- the close association of **axons** with **mast cells** & **epidermal Langerhans cells**→ the peripheral nervous system plays an role in modulating **inflammatory** & **immune reactions** in the **skin** ➔ modification of perceived **stress** or the **host's reaction to the stress** can potentially alter the clinical expression of dermatologic disorders
- ↓ stress→ biofeedback, behavior modification, & relaxation techniques: muscle relaxation, aromatherapy, yoga, & guided imagery
- → success in patients with **trichotillomania**, where behavior modification is key to resolution of the problem.
- Self-monitoring, hypnosis, & relaxation/mental imagery techniques → to treat patients with **trichotillomania**.
- Hypnosis has also been used to improve **alopecia areata.**
- **Aromatherapy (**using essential oils taken from plants for healing)→ can be viewed as a mind-altering intervention as well.
    - a mixture of **essential oils** (thyme, rosemary, lavender, & cedarwood) in a mix of vehicle oils (grapeseed & jojoba oils) **massaged into** the scalp daily

❑ **Strategies** for **Permanent Mending** of Hair

- The major constraint in using **chemical means** to achieve a permanent repair to damaged human hair is the fact that it is **attached to a living person**.
- **reactive low-MW compounds** that **absorb into the hair** & **react with the cortical proteins** → Ex, compounds that contain **alkyl groups** that have the effect of **reducing water swellability** → resulting in a positive effect on **mechanical strength.**
- Other compounds can react with hair **proteins** through **covalent bonds**, which act as **cross-linking agents** → **formaldehyde**, which is used in products designed to **straighten** the hair.
- Another category includes compounds that **polymerize within the hair**.
- small **monomeric intermediates** such as methacrylic acid in the presence of appropriate initiating agents will **react in situ** in the hair.
- there are not many hair repair systems currently available that provide permanent repair.

Practical Case Scenarios: How to Utilize Products

❑ **Case 1:**

- "My shampoo is too harsh."
- **A 38-year-old Asian male** presents to his dermatologist complaining of **coarse, dry hair.**
- He states that he has an **oily scalp** & has to **wash his hair daily** but says his hair feels particularly **dry after shampooing** for the past few months.
- He started to use a shampoo **formulated for men** with **oily hair** 8 months ago & thinks his shampoo may be too "harsh" for his hair.
- He worries that if he stops using his shampoo, his scalp & hair will **appear greasy.**

? What shampoos & conditioners should be recommended?

➢ This patient requires a deep cleansing shampoo & also some form of conditioning for his coarse hair.

- **Deep cleansing shampoos** contain **anionic detergents**, such as lauryl sulfates or sulfosuccinates.
- These shampoos remove sebum from the scalp & hair, but if used excessively can make the hair feel dry, harsh, & frizzy, & look dull.
- Those with **anionic surfactants** as the primary, secondary, & perhaps tertiary ingredients would be **too harsh** for this patient to use **daily.**
- He could use these products **once or twice a week** for deep cleansing followed by a **rinse-off conditioner**.

- On other days, he could use a **milder shampoo** with both cationic & anionic surfactants
- These shampoos are usually recommended for **dry & chemically treated hair** because they less effectively remove sebum from the hair compared to anionic surfactants.
- Also, **2-in-1 shampoo/conditioners** are a good option for those who **shampoo daily** → contain cleansing surfactants & conditioning substances such as silicone, hydrolyzed silk, animal proteins, glycerine, PVP, PG, & stearylkonium chloride.

The Main Surfactants in Shampoos[a]

General Characteristics of Surfactants and Use with Hair Type and Scalp Oiliness		
Class	**Example**	**General Characteristics**
Anionic	Ammonium lauryl sulfate, sodium laureth sulfate, sodium lauryl sarcosinate, sodium myreth sulfate, sodium pareth sulfate, sodium stearate, sodium lauryl sulphate, alpha-olefin sulfonate, ammonium laureth sulphate	Deep cleansing: types of hair: normal and oily hair; clear shampoo for anti-residue purposes When combined with other mild surfactants, may be used for normal hair and hair with oily scalp and dry tips When used with kinky textured hair, must be in a very low concentration and combined with other mild surfactants plus conditioning agents (silicones, oils) to minimize hair fiber friction
Cationic	Trimethylalkylammonium chlorides, and the chlorides or bromides of benzalkonium and alkylpyridinium ions	Hair softener: used in combination with anionic surfactants Mild cleansing: for textured hair, dry hair, chemically treated hair; for daily use on normal hair and oily hair with dry distal ends
Nonionic	Fatty alcohols, cetyl alcohol, stearyl alcohol, and cetostearyl alcohol (consisting predominantly of cetyl and stearyl alcohols), and oleyl alcohol	Mild cleansing for damage-prone, brittle, textured, chemically treated hair
Amphotheric	Alkyl iminopropionates and (amido)betaines	Moderate cleansing: combination treatment with anionic surfactants for daily use in people with oily and normal hair with dry distal ends Does not irritate the eyes and is found in baby/children's shampoos

[a] Each class is recommended for a different hair type.[2–4]

- Ultimately, the patient could alternate between 2-in-1 shampoos, mild shampoos, & deep cleansing shampoos followed by conditioners to achieve his desired cosmetic result.
- **Anionic surfactants** are the strongest & have higher cleansing abilities.
- **Cationic surfactants** & **mild cleansing agents** are added to shampoos for an additional **conditioning effect**.
- **Non-ionic surfactants** → **mild** & have a low cleansing capacity → typically used in shampoos for **damaged or chemically treated hair**.
- **Amphoteric surfactants** → are the **most mild**, & frequently are used in **baby shampoos**.

❑ Case 2:

- "My hair **feels dry & breaks** more often since I started **dyeing it.**"
- A 25-year-old Caucasian female presents to her dermatologist complaining of ↑ **hair breakage** over the past **2 years**.
- She naturally has dark brown hair, but since the age of 21 has her hair professionally **dyed** to a light brown-blond color & **highlighted** ever 3 months.
- She washes her hair twice/week with a **shampoo & a conditioner** for **color-treated hair**.
- **She blows her hair dry after** showering & then uses a **flat iron.**
- Clinical examination of the scalp hair shows dry, brittle hair fibers with breakage seen on hair pull test.
- Distal splitting of hair fibers is present.

? What should her dermatologist recommend?

- damaging changes to the hair fiber → lipid loss disulfide bond cleavage AA degradation cysteic acid formation
- **alkaline products** (ex. hair dyes, perms, or relaxers) can deplete the hair fiber's **protective lipids**: especially 18-MEA, the epicuticle's main lipid, which coats the surfaces of abutting cuticle cells & gives hair its natural **hydrophobicity**.
- Lack of hydrophobicity → ↑ water absorption, frizz appearance of dullness ↑ friction between hair fibers.

- Without 18-MEA's protective seal, **protein loss** may also occur.
- H_2O_2 in hair dyes & bleaching products → ↑ protein degradation by cleaving both disulfide bonds & peptide bonds first in **cuticle cells** & later in **cortical cells**.
- **Oxidative cleavage of disulfide bonds** converts cysteine to cysteic acid → loss of mechanical strength ↑ fiber porosity.
- **Hair bleaching agents** can also cause protein loss through the decomposition of melanin granules.
- Melanin provides the hair with both pigmentation & **photochemical protection** by absorbing & filtering UV & visible light.
- These changes to the hair fiber chemical & physical properties can lead to→ **split ends (trichoptiolosis)** hair breakage rough surface texture ↓ luster ↓ strength.
- Our patient's hair coloring history is suggestive of hair **bleaching**, which is **the most damaging** form of hair coloring
- It involves removing the hair's natural color & replacing it with a **lighter shade**.

➢ the primary recommendation is avoidance of hair coloring & excessive heat application.

- If complete avoidance is not desired, she can opt to not bleach her hair, but rather to dye it with permanent dyes or semi-permanent dyes up to two shades lighter than her natural color.
- She should be advised to add more **moisturizing** shampoos & conditioners in her hair care routine.

- For example, mild shampoos with low [anionic surfactants] would be best.
- 2-in-1 shampoo/conditioner products that contain lower levels of anionic surfactants → beneficial to **moisturizing her dry, damaged hair**.
- Deep conditioning treatments could also be advised & performed at least **weekly**: applying **oil or cream**-based **conditioners** that remain on the hair for 15 minutes for better penetrance into the hair shaft.
- The penetrance of the ingredients depends on their MW → deep conditioners contain **heavy molecules** (higher > 250 kDa) that **take longer** to absorb.
- Protein-containing deep conditioners can **temporarily** replenish damaged areas on hair shafts devoid of cuticle scales.
- Eluded protein cannot be restored, but **hydrolyzed amino acids** may help temporarily mend cracks & split ends, ↑ the strength of the hair fiber, & improve resistance to breakage *their effects are washed out with water exposure ➔require reapplication after shampooing.
- Leave-in conditioners & styling conditioners, such as **heat protectant products**, can be used **prior to styling the hair**.
- Most of these products contain **silicone,** especially **dimethicone**, which thinly coats the hair shaft to **restore hydrophobicity**, **smooth down cuticle scales**, ↓ frizz, & protect the hair from damage.
- The addition of 18-MEA to hair care formulations for damaged, color-treated hair … → these formulations can restore the healthy appearance of hair by replenishing 18- MEA to the hair fiber & ↑ he overall hydrophobicity of the hair

Recommendations for Patients with Hair Breakage[14]

- Avoid bleaching; use permanent or semi-permanent hair dyes instead.
- Limit the number of chemical treatments to no more than 2 to 3 a year if possible. White roots that need to use dye every month should need deep conditioning shortly after the process..
- Perform chemical treatments with the product selectively applied to the roots if the ends were previously treated, and work with an experienced stylist.
- Wash hair with conditioning shampoos with low concentrations of anionic surfactants, followed by a moisturizing conditioner; 2-in-1 conditioners are advised.
- Deep condition at least weekly, as deep conditioners with silicone, vegetable oils and protein can strengthen hair fibers.[15]
- Comb damp-to-dry hair with wide-set, blunt-tooth combs, because wet hair is more elastic and subject to fracture.
- Let hair air dry when possible.
- Use blow-dryers when styling hair, as these are much less damaging than flat irons or curling irons.
- Never use curling and flat irons on wet hair.
- Use heat protectant products on the hair before styling.
- Keep the temperature of styling tools below 375°F.
- Trim damaged hair frequently to help minimize additional breakage.

❑ Case 3:

- "Am I a good candidate for the **Brazilian keratin treatment (BKT)**?"
- A 27-year-old Brazilian female with wavy-to-curly hair would like to **straighten** her hair with the BKT.
- She dyes her hair every 2 to 3 months, & has dry, frizzy hair with breakage.
- She is interested in the BKT, because she has heard that the treatment straightens, adds shine, & ↓ frizz while fortifying the hair with keratin.
- She would like to know if she is a candidate for the BKT given her previous history of color treating her hair, & is also interested in understanding what products she could use to protect her hair from further damage.

? How should her dermatologist advise her?

- The BKT is a hair straightening procedure that uses ~~formaldehyde~~, ~~glutaraldehyde~~, or formaldehyde releasers combined with hydrolyzed amino acids & silicones to straighten hair fibers.
- It may also be referred to as albumine hair straightening acetic acid treatment hair botox hair plastic treatment.
- Formaldehyde replaced by glutaraldehyde, a potentially 10 X more **mutagenic & neurotoxic** product
- At these high [formaldehyde] in the BKT, consumers complained of a burning sensation in their eyes, mouth, & nose.
- ➔ formaldehyde-releasers, such as methylene glycol & glyoxylic acid, were formulated to help ↓ sensorial discomfort.

❖ However, both methylene glycol & glyoxylic acid release formaldehyde when heated during blow-dry & hot iron application.

- The BKT → could be used on bleached, dyed, or chemically processed hair & give hair a smooth, shiny look (Figures).

❖ to provide adequate ventilation, appropriate personal protective equipment, & sufficient training information about hazardous chemical exposure to workers performing treatments.

  - For example, salons are supposed to test the formaldehyde level in the air during treatments to ensure it does not exceed the 15-minute short-term exposure limit of 2 parts formaldehyde per million parts air (ppm).

(a) Before and (b) after BKT on patient with thick, curly hair.

- The mode of action of **formaldehyde** is different from **other relaxers**, because formaldehyde is not a hair straightening substance… it forms crosslinks between keratin molecules.


(a)

- formaldehyde crosslinks hair keratin to the exogenous hydrolyzed keratin in the BKT solution.
- When applied to the hair, hydrolyzed keratin diffuses into the hair shaft & crosslinks with the hair keratin in the presence of formaldehyde & heat, ultimately realigning the hair shaft.
- Heat via blow drying & flat ironing of the hair not only enhances the crosslinking, but also reinforces the straightening of the hair & seals the cuticle to add shine to the hair.
- **Light reflecting off** of the re-aligned keratin filaments makes the hair appear **brighter & shinier.**


(b)

❑ The BKT application process begins with washing the hair with an **anti-residue shampoo**.

- Then the hair is towel-dried & the BKT product is applied section by section to the damp hair using an application brush & comb.
- After the product is applied, the hair is blow-dried straight with a paddle brush or round boar bristle brush.
- Half inch or one-&-a-half inch sections of the hair are pressed straight at least 15 to 20 times with a flat iron that reaches 380°F to 450°F.
- This process seals the product into the hair & also releases **vaporized formaldehyde**, which can irritate the eyes, nasal passages, & oropharynx.
- Some salons offer **wet towels** to be applied over their clients' nose & mouth during the procedure.
- The next step is **optional**, with the solution rinsed off with warm water (but not **shampooed**) & the hair blow-dried again.
- Some salons recommend waiting 3 days **before** shampooing the hair.
- The treatment is gradually washed off over time with shampooing, & the hair's natural, stronger keratin bonds begin to predominate typically within **10 - 12 weeks**.
- ➔ the BKT is a **temporary treatment**, lasting < traditional relaxers, but is also **less damaging** to the hair.
- ➔ the BKT can be used by people with previously relaxed or color-treated hair, such as the patient in this case.
- Hair may be colored any time **before** the BKT or at least **2 weeks after** the BKT.

- there are no studies showing that the BKT can **penetrate & strengthen the hair**.
- → the BKT can **damage the hair**, because the application process uses **high temperatures** to blow-dry & flat-iron the hair straight.
- **formaldehyde** is a presumed **carcinogen** & can cause an **irritant** or **allergic** contact dermatitis.
- BKT companies also market **sulfate-free & sodium-free** shampoos & conditioners to be used after a keratin treatment.
- They claim that **sulfate & Na** can **strip the hair** of the keratin treatment, leaving the hair **dry** & diminishing the **duration** of the BKT
  - ❖ there is no evidence that the surfactants & Na in shampoos & conditioners **deoxidize keratin bonds** to cause stripping of the BKT.
- For this patient, using a **moisturizing shampoo & conditioner**, such as one for damaged or color-treated hair, would be advised.

- Dry Hair

❑ **Case 4: “**

- Why is my hair so tangled? Am I not using enough moisturizers?”
- A 42-year-old Caucasian woman with fine hair → complaining that her hair looks dull & is “difficult to comb.”
- She applies a conditioning mask to her hair 3 times/ week **before** washing her hair with a shampoo & a conditioner for color-treated hair.
- She then applies a palm-size amount of **leave-in** conditioning **cream** to her damp hair.
- Despite using more conditioners & leave-in products, she states that her hair is **tangled & difficult to comb**.

? How should this patient be advised?

- **Difficulty managing tangled, dry hair** is a common complaint for **female patients**.
- the more patients try to “treat” their dry hair with deep conditioning & leave-in conditioners, the worse their symptoms may get.
- This is because the overuse of hair conditioners often leads to the deposition & buildup of residue on the scalp & the hair.
- Residues made up of polymers, cationic surfactants, anionic surfactants, & silicones from conditioners, but may even include metals.
- These **insoluble products** deposit on the hair shaft under the cuticle scales ➔ lifting the scales & causing frizz & tangling.

- This patient would likely benefit from an **anti-residue shampoo**.
- Anti-residue shampoos with laureth ammonium effectively remove residue deposition on the scalp & hair.
- These shampoos are **excellent cleansers** but are **drying**.
- ➔ shampooing should be followed by the application of a **moisturizing rinse-off conditioner**, preferably one with hydrolyzed AAs, silicone, & vegetable oils.
- The anti-residue shampoo may be used once or twice /week, as needed.
- Color-treated/bleached hair & ethnic hair are especially susceptible to **excessive drying** & **hair stripping** from anti-residue formulations ➔ For these types of hair, a shampoo with a mild surfactant but no conditioning agents is recommended.
    - For example, baby shampoos, which contain amphoteric surfactants & have a pH around 7.0, may be recommended.
        - These shampoos' relatively **alkaline pH** (compared to **hair pH** of 3.67) can gently **open the cuticles** to remove residues from the hair shaft.

❖ In general, **baby shampoos** do not contain **moisturizing products** ➔ should not be used frequently by patients who have **chemically treated hair.**

- The patient should also be guided in choosing the **vehicle** for hair treatment…
- The right vehicle can help this patient achieve a perceivable hair conditioning effect without any stickiness or excessive buildup.
- Ideally, **leave-on products** should → **dry quickly**, leave **negligible** amounts of residue on the scalp & the hair, & give hair good **manageability** & a **soft feel.**
- **Creams & ointments** are often **too thick** & can leave noticeable residue.
- **Gels** can make the hair feel **hard & sticky**.
- Recommended vehicles include **hydro-alcoholic product** **some oils** **foam** ✓
  - **Hydro-alcoholic vehicles**, which are formulated from alcohol & hydrotropes (i.e., humectants) → create a fairly quick-drying system that evenly re-distributes the sebum from the scalp & hair shafts, leaving hair with a soft, manageable feel.
  - **Oils,** especially those diluted with **volatile silicone**, can provide a light application feel.
    - "**Dry oils**" that contain isopropyl myristate & di-isopropyl adipate leave a non-greasy residual feel on the hair.
  - **quick-breaking foams** → distribute ingredients in the hair evenly without excessive buildup.
  - Foams wet the hair slightly when first applied.
  - As the solvent evaporates & the propellants disappear, the formula evolves to leave a soft-touch coating on the hair.

ANTI-AGING

- **chronic persistent inflammation** → crucial role in **hair aging** & in various hair diseases: Inflamm-aging ➔ **Antioxidants…**

  - **Phenolic antioxidants** isolated from **plants**, such as flavonoids flavonoid glycosides catechins (-)-epigallocatechin-3-gallate (EGCG) from **green tea** resveratrol ellagic acid quercetin extracted from **fruit & vegetables (**red grapes/wine peanuts green tea black tea soy citrus fruits berries cherries turmeric**)**→ **stabilize oxidative radicals** & have a**nti-inflammatory** & **antimicrobial effects**
    - EGCG, → stimulate **hair growth** through dual **proliferative & anti-apoptotic** effects on **dermal papilla cells**
  - Activation of the **arachidonic pathway** is another hallmark of **inflammation** → can be the target of **anti-inflammatory agents** ➔ NSAIDs → **anti-aging strategy**
  - **l-ascorbic acid 2-phosphate**, a derivative of **l-ascorbic acid** → **anagen inducer** in dermal papilla induces the **early transition** from **telogen phase to anagen phase** the growth of human dermal papilla cells promotes elongation of hair shafts

- **4-*O*-methyl honokiol,** a neolignan compound from *Magnolia officinalis*→ have a hair **growth-promoting effect**.
- **isoflavone** → **enhancement of hair follicle morphogenesis hair regrowth hair pigmentation**
  - oral **capsaicin** (6 mg/day) & **isoflavone** (75 mg/day) for 5 months led to a significant **hair-promoting effect**
  - **Combinations** of different **antioxidants** → **additive or synergistic** effects
- **Topical application** is <u>not</u> suitable for **hair-bearing skin**, & the extent of **penetration** remains to be optimized.
- The efficacy of **systemic application** of **antioxidants** in targeting hair follicles …?
- **Shampoo** containing **antioxidants** may <u>not</u> be a practical anti-aging treatment for hair follicles

ANTI-AGING HAIR CARE PRODUCTS

- Anti-aging hair care → **topically & in ingestible** form
- The **hair shaft** lacks **biochemical processes** → **hair is dead** & **cannot be repaired & restored**.
- the **root of the hair shaft** is **alive** ➔ hair treatments using **anti-aging ingredients** such as **small-MW peptides** **AHAs** **certain vegetable oils** **AAs** **peptides** **ceramides** can provide benefits to both the **shaft & the hair root.**
  - **low-MW compounds** penetrate the **cuticle layers** of the hair **shaft** → enhancing its **softness, protection, & manageability**.
  - They can penetrate the **scalp**, enhance scalp micro-circulation, & improve follicle health➔ promoting healthier new hair growth
- **Ingredients** for **hair care**: **silicones** for **shine** **quaternary ammonium** compounds for **ease of combing** **thickening** approaches such as **proteins** **high-MW poly quaternium polymers** for **conditioning** **PVP** for **shaping & styling**

o hair care products with **glycolic acid** (marketed as DuPont™ Glypure):

- **penetrates** through the **hair shaft** & delivers **enhanced protection & manageability** to hair by **conditioning, moisturizing, strengthening, & preventing breakage**
- It also **moisturizes & exfoliates** the **scalp**, resulting in **less flaking** to give the scalp a healthy look & feel.

❑ slow hair aging—silicone… silicones → provide **color retention** & **strengthening** properties to hair.

- **Amino functional** silicones are able to **strengthen hair** by **forming a film** along the fiber shaft, essentially **sealing** in the cuticles.

- the film can provide **protection** to hair, **sealing the hair cuticle**, → helping prevent **moisture penetration** into & out of the hair cortex to **maintain** an optimal **moisture l**evel for hair strength

- enhance hair strength & aid in color retention when **incorporated into permanent hair colorants** or **rinse-off conditioners.**

- The amino silicones have a **better deposition** on hair [than other silicones]➔ they can better bind to damaged hair,"

- The amino silicones were **formulated** into dilute leave-on & rinse-off conditioners for its ability to **seal in moisture**.

- Although silicones provide a film to the hair→ they do **not build up**, which is a significant **concern** for consumers.

- silicone **does wash off**

❑ **polysilicone-15** → has UV filter moieties attached to the silicone backbone.

- **The silicone** provides **shine**, **conditioning** & s**moothening** to the hair **the UV filters** provide protection against UV degradation & color change of the hair.

- as a **UV filter** for **hair protection** & ↓ **the combing force** necessary ↑ **the shine** attribute of a formulated product ↓ UV induced fading.

- It is photostable & has a **good safety profile** due to its **large molecular size**.

- Ingredients which enhance hair shine usually have **high refraction indexes** & **spread uniformly** on the hair fiber.

Hair Care Ingredients	Benefits	Supplier
Crodafos™ HCE	Increases color intensity & color uptake. Provides better color wash fastness. Reduces hair damage as shown by hydrophobicity & combing studies.	Croda Inc
Incroquat™ Behenyl TMS-50	Hair conditioning agent, suitable for cationic emulsions, provides soft touch.	Croda Inc
ChromAveil ®	Protects the hair from the damaging effects of sunlight. Gives color protection benefits to dyed hair from UVA & protects the mechanical properties of the hair from UVB.	Croda Inc
Crodasorb™ UV-HPP	Polyester poly quaternized ingredient that is substantive to hair & protects against the damaging effects of **UV-B radiation.**	Croda Inc
Lustreplex®	Creates lustrous, healthy-looking hair from anionic systems. Provides frizz control, shine, detangling, & conditioningbenefits.	Croda Inc
Dow Corning® CE-8411 Smooth Plus Emulsion	Repairs colored, gray, & heat-damaged hair by restoring moisturized feel, shine, & alignment. Protects hair from further damage & color loss.	Dow Corning
Dow Corning® 5-7113 Silicone QuatMicroemulsion	Restores smoothness, shine, & Alignment. Prolongs hair color. Protects hair from breakage.	Dow Corning
HYDROVANCE®	Improves water retention & helps to strengthen & even repair damaged hair, for benefits the consumer can clearly feel & see.	Akzo Nobel
STRUCTURE®PQ-37P	Cationic acrylic homopolymer multifunctional rheology modifier that provides thickening & conditioning.	Akzo Nobel
Procapil™	Reinforces hair anchoring. Reduces hair loss.	Sederma
Glypure® glycolic acid	Glypure® penetrates the hair shaft to enhance the softness & manageability of hair.	DuPont
L-Arginine	Helps hair regrowth by stimulating the production of new hair follicles. It nourishes the hair root & strengthens hair.	Ajinomoto
PARSOL® SLX	PARSOL® SLX is a **silicone-based** UV-B absorber. Delivers multiple benefits including prevention of color fading, gloss enhancement, & conditioning.	DSM

- **Pantene** has launched **PRO-V Expert Age Defy** shampoo, conditioner, & advanced **thickening** treatment designed to work together for **thicker** hair strands → These products are claimed to be **gentle** enough for **daily use** on **color-treated hair**.
- Formulated with a **triple blend complex** (mixture of AAs), the shampoo & conditioner help fight 7 signs of aging hair: ↓ breakage prevents split ends ↓ frizz controls unruly grays minimizes lackluster color improves a thin look minimizes dryness
- **Nexxus** has launched its **first anti-aging range** of products that combats 8 signs of aging hair: volume loss breakage roughness less shine dryness brittleness unruliness loss of color vibrancy.
- It **replenishes & revitalizes** for more **vibrant, youthful-looking** hair.
- Nexxus Youth Renewal™ Rejuvenating **Shampoo** gently **cleanses hair** to help rebuild **volume, vibrancy, & vitality**.
- Nexxus Youth Renewal™ Rejuvenating **Conditioner** provides **lightweight nourishment** to help preserve **volume, vibrancy, & vitality**.
- Youth Renewal™ Rejuvenating **Elixir** **lightweight leave-in treatment** helps rebuild hair's strength by ↓ **breakage** while making hair look more **youthful & vibrant** in just 7 days.

- **Alterna** has launched CAVIAR Anti-Aging® Replenishing line of products comprising **moisturizing shampoo & conditioner** that transforms **dry, brittle hair** by **sealing** in a rich **blend of lipids** & essential ingredients to continually nourish & hydrate the hair.
- The shampoo is a **luxurious**, **sulfate-free cleanser** that restores **moisture** while protecting hair from **color fade**, **daily stresses**, & future **damage**.
- Both shampoo & conditioner are infused with Seasilk® Age-Control Complex® Enzyme therapy® Color Hold®.

➢ helps **maintain moisture** protects from **daily stresses** delivers what your hair needs to become strong, healthy, & younger-looking.

- The anti-aging rapid repair spray helps add **moisture & vibrancy** to hair while combating natural, chemical, & environmental stresses.
- It may be used as a **thermal protectant** when applied **pre-styling,** or as a **finishing shine spray.**
- **Keranique®** has launched a hair **revitalization system** developed for **women** to **strengthen, fortify, & thicken** each & every hair shaft.
- There are 3 key components to the Keranique® System.
  - Step 1 includes a revitalizing shampoo & volumizing conditioner.
  - Step 2 has the hair regrowth treatment with clinically proven FDA approved ingredient, Minoxidil
  - Step 3 is an amplifying lift spray to provide fullness, volume, & body.

❑ **Cuticle De-cementation** & its Repair

- **cuticular damage** can occur without being detected by changes in **tensile strength**.
- The weathering of the **tip sections of hair** resulted in a **higher degree** of **cuticular lifting** & a **lower % extension**.
- Although the **mechanical properties** would be reversible, the **reversion of the cuticulae** was not.
- as the hair was being **stretched**, shear forces in the endo-cuticle, the **least cross-linked area of the cuticle**, would suffer the most **stress & fracture.**
- The cuticle would then **lift** & expose the **fractured endo-cuticle**.
- cuticle lifting ↑ with→ the **# of applied tensile cycles** **sensitive to moisture**: @ lower humidity levels it took less strain @ high humidity the endo-cuticular region of the cuticle is **plasticized** & is more **pliable.**
- It is able to **hold more moisture** due to its **lower cross-link density**.
- when the **cortex** is **swollen with water** → **less** of a Poisson **contraction**, which normally **puts stress** on the **cuticular envelop** during **strain**.
- By putting certain **poly siloxane-modified compositions** on hair with lifted cuticles, a **re-cementing** would take place in that the cuticles would not lift with subsequent strain → entail **cross-linking**
- **The dried films** of these compounds formed **insoluble films** despite the drying conditions, providing evidence for **cross-linking**

❑ Repair of Split Ends

- They form through the **shear stresses** @ work as a **comb or brush** is pulled through the hair & eventually produces the **longitudinal fracture**
- usually accompanied by other manifestations of damage→ ends being **un-manageable** during styling **hard to comb** through lacking **shine**
- **To repair** split ends & restore hair to its normal state → a **poly electrolyte complex** that is able to **semi-permanently** mend the damaged ends.
- The semi-permanence → having the **durability** to further **mechanical action** such as **combing**
- **Cationically charged domains** of the **microgel**, which are based on **unassociated moieties** of the cationic polymer, interact **electrostatically** with the **cortical proteins**, which are **predominantly anionic.**
- Also, **anionic domains** of the **microgel** work as an adhesive through **HB.**
- Microgels → act as **cross-linking structures** to draw together & bind the broken parts of the fiber in such a fashion that the split ends will not open up with the stress of subsequent combing.