



# Co enzyme Q10: An excellent Novel Molecule for Hair Damage Treatment

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**Abstract-** Hair has always had a psychological and sociological significance on a person's personality and general appearance. This review article on coenzyme Q10 for hair growth. It is a fat-soluble vitamin-like molecule that occurs naturally in every cell membrane in our body. Coenzyme Q10 plays a critical role in cellular energy production and hair growth. While coenzyme Q10 has several potential health benefits, including its role in maintaining skin health and supporting overall body functions, there is limited scientific evidence of its direct role in promoting hair growth. Research has linked coenzymes to an increase in cellular energy and blood flow, which may help meet the high energy demands of hair follicles. It has an anti-ageing effect on hair health because it boosts the process of gene expression involved in the synthesis of keratin (a protein in hair), especially proteins that are affected by the ageing process. On the other hand, this review article will help researchers for further research.

**Keywords -** Coenzyme Q10, antioxidant, endogenous compound, keratin, hair fibers, hair damage treatment.

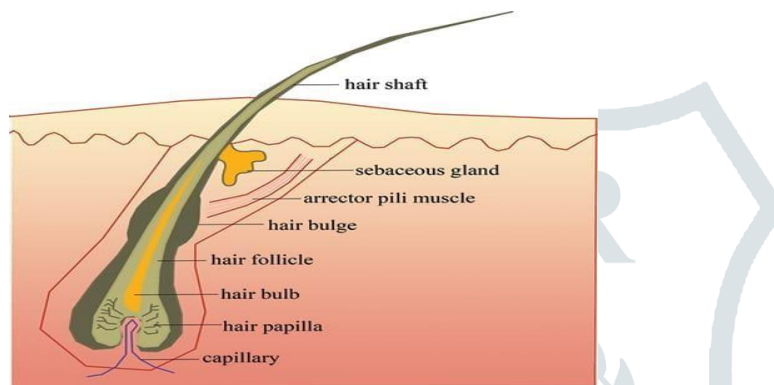
## Introduction

Despite the fact that dermatologists are specialists within the remedy of scalp and hair conditions, the aesthetics of a few beauty treatments stay elusive. Knowledge of hair cosmetics and aesthetic tactics and the structure and bodily behavior of the hair is very important in contemporary clinical exercise (1). Although hair cosmetics are extensively available, medical literature is scarce and professional literature is genuinely no longer to be had. The purpose of this chapter is to provide a better information of the shape and behavior of hair, in addition to data about hair cosmetics. Knowing their mode of movement, safety and components allows the health practitioner to better investigate the diverse secondary problems of splendor remedy. Cosmetic hair care processes are normally utilized by ladies of African descent, whose hair fragility has been related to worsening hair care practices. In line with McMichael (2) fragility main to hair breakage can be due to genetic predisposition, weather because of special hair care practices. Hispanic patients also have curly or very curly hair, which can clinically behave as sensitively as African hair while uncovered to hair care processes. Despite the fact that there is no medical records to show if Hispanic hair is as sensitive, it's far commonplace for Hispanics with chemically straightened hair to be afflicted by hair breakage and are looking for assist and recommendation from a dermatologist to clear up the problem. It is also critical to distinguish hair loss because

of telogen dropping from hair loss because of breakage of the hair shaft, which isn't always clean from the patient's factor of view <sup>(1)</sup>.

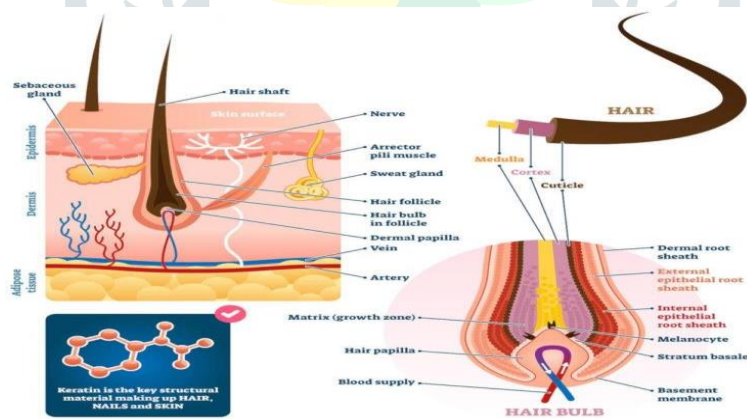
## Hair

Hair is made from a tough protein called keratin. It is easy in structure however has a critical feature in social sports. (1) the time period trichology approaches the examine of hair and scalp. The time period comes from historic Greek. Tricho manner hair and log studying. [2] hair is a protein filament that grows from follicles inside the epidermis. The word hair commonly refers to 2 distinct structures. The component below the pores and skin is referred to as the hair follicle. The difficult, fibrous part that extends above the surface of the pores and skin is referred to as the stalk. Hair increase starts off evolved inside the hair follicle. [3] by using the 22nd week of fetal life, we all form five million hair follicles. Approximately one hundred,000 of them are on the scalp. It is the largest quantity of scalp hairs. [4]



**Figure no.1. Anatomy and physiology of hair**

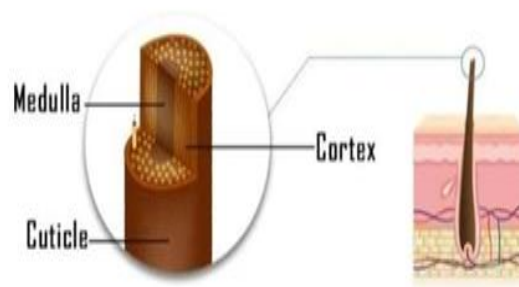
Hair follicle is one of the characteristic features of mammals serves as a unique Miniorgan.



**Figure no.2: Role of hair follicles**

According to analyze in the literature, hair is a good deal greater complicated than meets the attention. It includes several layers, chemical bonds, and proteins. Looking at the whole chemical composition of hair, it is miles about 45% carbon, 28% oxygen, 15% nitrogen, 7% hydrogen, and five% sulfur. Hair additionally incorporates 12-15% water and a small quantity of positive minerals which includes calcium, cadmium, chromium, copper, zinc, iron, and silicon. At the cell stage, there are distinctive types of bonds, such as hydrogen bonds, salt bonds, cystine bonds, sugar bonds. Hair is particularly made from a special protein known as keratin. This is the equal protein that still forms the outer layer of human pores and skin and nails. Keratin protein consists of amino acids related via a polypeptide chain known as an alpha helix. This chain of alpha helices is linked by means of chemical bonds that deliver hair its unique houses such as shine, energy, jump, etc. Those bonds also are accountable for making hair kinky, curly, or directly.

Know-how hair structure hair is made up of a structural protein known as keratin. That is the equal protein that makes hair, nails and the outer layer of skin. It protects epithelial cells from harm or pressure. It is far quite robust and wear-resistant. Microscopic analysis of hair shows three awesome layers. The layers that make up the hair fiber are the cuticle, cortex, and medulla.



**Figure. 3: Microscopical structure of Hair**

### Hair Growth cycle

The boom and lack of hair may additionally appear growth like a simple method, however the hair growth cycle consists four wonderful stages. There are anagen, catagen, telogen and exogen.

Like skin, hair is formed by means of speedy division and differentiation of stem cells, giving upward thrust to keratinocytes that migrate, flatten, and die to form keratinized cells. The very last hair product exposed to the surface of the pores and skin consists entirely of keratin. Hair follicle growth is cyclical. Phases of speedy boom and elongation of the hair trade with intervals of rest and regression pushed by apoptotic indicators. This cycle can be divided into 3 levels: anagen (growth), catagen (transition), and telogen (relaxation). Anagen increase is the active segment all through which the hair follicle takes a bulbous shape and produces hair fibers. The anagen section can be similarly divided into Proanagen and Metanagen phases. Proanagen causes the follicle to multiply hair progenitor cells and start the differentiation manner. New hair appears at the surface of the pores and skin, marking the methanogen phase. The anagen section can remaining several years. The catagen segment starts at the quit of the anagen section and is characterized via the transition to a resting kingdom. For the duration of this section, which can last numerous weeks, the hair follicle undergoes apoptosis-induced regression and loses approximately one-sixth of its regular diameter. At some point of this period, the formation of hair also takes place, that's an vital prognostic indicator in the evaluation of hair pathology. If numerous hairs shape at the identical time after which fall out, it can look like thinning. Some situations wherein this will arise include (but are not restrained to) hypothyroidism, hyperthyroidism, stress, diet deficiencies, and the postpartum length. Next is telogen, or the resting segment of the hair cycle, where the hair follicle rests and the hair does no longer develop. Approximately 10-15% of all body hair is in this resting section at any given time and can stay in this country for various amounts of time relying on wherein the hair is located - everywhere from a few weeks to almost a week at the eyelashes. Of the yr for scalp hair. The precise mechanism that controls the transition from one segment to some other isn't absolutely understood. In line with the onion activation theory, increase elements produced in the dermal papilla stimulate stem cells within the tuft to proliferate and modulate boom section transitions. Due to the fact these cells are transiently proliferating cells, they are able to go through simplest a restrained quantity of mitoses, which determines the duration of anagen and the beginning of catagen levels.[6] the hair follicle and its product also are one of the few regions of the body blanketed from immune surveillance by using a phenomenon first defined by means of sir peter Medawar in 1948 as immunity (ip). Ip is carried out by way of nearby manufacturing of numerous important follicular histocompatibility complexes, immune modulators which include TGF-beta, and FAS ligand expression to kill autoreactive t cells. (5)



Figure no.4: stages of hair growth cycle

## Hair damage

Wholesome and delightful hair is desirable for plenty people whose hair has been broken with the aid of chemical remedy, heat styling and environmental elements. Various hair care merchandise was developed to decorate the beauty of hair. Distinctive information of the shape and residences of the hair surface is essential for the development of precise hair care techniques. The cuticle is placed outside the hair fiber and protects the cortex. It's been proposed that the outer floor of cuticle cells is blanketed by means of a monolayer of covalently certain fatty acids, the principle aspect of which is 18-methyleicosanoic acid (18-mea) (5,6,7,8). 18-mea is an unusual ram-chain fatty acid. It's far covalently connected, possibly via a thioester or ester bond, to the cuticle surface of hair fibers (9,10,11,12). 18-mea is known to create a hydrophobic surface and act as a boundary lubricant, reducing frictional resistance among hair fibers (thirteen,14,15,16,17,18,19). 18-mea is easily eliminated via alkaline remedies together with hair dyeing or perming, and the surface turns into hydrophilic and friction will increase (13,14). The loss of 18-mea is one of the motives for the increased friction of the cuticle surface. This can affect the sensory notion of the hair, inclusive of feeling dry and difficult to brush/run with hands (eleven).

## Causes of damaged hair (20)

Hair damage and breakage tend to happen when a person exposes their hair to harsh conditions or over-styling practices.

1. Use of heated styling tools, such as blow dryers, flat irons, or hot combs
2. Chemical processing including perms, coloring, and bleaching
3. Overexposure to the sun and swimming pool chemicals
4. Infrequent hair trimming
5. lack of conditioning
6. Brushing too often

In some cases, medical can damage hair:

Malnutrition: According to 2015 research, a person's nutritional health has links to the quality of their hair. Vitamins A and B-12, folate, selenium, and iron may affect hair quality.

Hormones: Hormone imbalances can cause a person's hair to become thin or weak. Both polycystic ovary syndrome (PCOS) and menopause can cause a person's hair to become thinner.

Thyroid disease: Hypothyroidism, which occurs when the thyroid is unable to produce enough thyroid hormones, can cause thinning hair, according to the National Institute of Diabetes and Digestive and Kidney Diseases Trusted Source.

Autoimmune disorders: Autoimmune connective tissue diseases, such as lupus and scleroderma, can cause a person's hair to become fragile and thin.

Damage level	Consumer language	Color/perm frequency
highly	Consumers who constantly perm and color their hair, feel hair very dry and tangling when washing. Hair is very fragile with split ends.	Color only/straighten only/perm wave only Color+straighten/color+perm wave More than 3 times per year
middle	Consumers who recently permed or colored hair, feel hair a little dry during washing and fussy in tips. Hair feels lack of water and not discipline.	Color only/straighten only/perm wave only Color+straighten/color+perm wave 2 times per year
slightly	Consumers who had slightly perm, color or sun damage behavior, whose hair begins to turn yellowish and lusterless.	Color only/straighten only/perm wave only 1 times per year
natural	Consumers who never perm and color their hair, whose hair is black and shine, might have some oily problems.	Never

Figure no.5: level of hair damage

## Coenzyme Q10

CoQ10, also called ubiquinone, is a fat-soluble vitamin-like molecule found naturally in every cell membrane in our body. It is a normal part of the diet, but it is also synthesized endogenously. It is necessary for the proper transfer of electrons in the mitochondrial oxidative respiratory chain and the production of adenosine triphosphate (ATP) (21). CoQ10 can increase the production of important antioxidants such as superoxide dismutase, an enzyme capable of reducing vascular oxidative stress in hypertensive patients(22). CoQ10 reduces the level of lipid peroxidation by reducing oxidative compounds (23). CoQ10 can improve circulation and protect blood vessels by preserving nitric oxide. Dietary supplements provide CoQ10 in either oxidized (ubiquinone) or reduced (ubiquinol) form. The bioavailability of a particular CoQ10 supplement depends on the lipid carrier in which it is incorporated and the added preservatives (24).

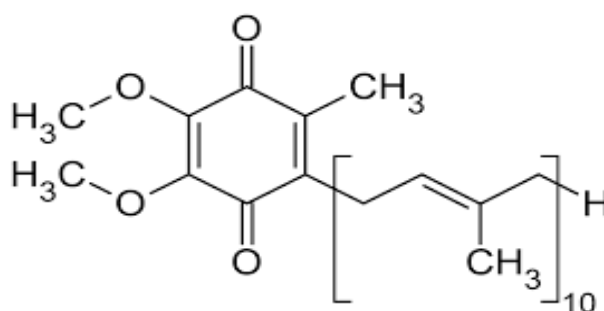


Figure No 6- Structure of Coenzyme Q10

**Scientific Names:** Ubiquinone, Ubidecarenone, Mitoquinone (42-44)

**Common Names:** Co-Enzyme Q10, Coenzyme Q10, Co-enzyme Q-10, Co Enzyme Q 10, CoQ, CoQ10, Co Q 10, Co-Q-10, CoQ-10, CO Q10, Q10, Vitamin Q10 (42-44)

**Description of active ingredients:** Coenzyme Q10 is the active ingredient. The term "Coenzyme" denotes it is an organic, nonprotein molecule. The "Q" refers to the quinon

chemical group and the "10" refer to the 10 Isoprenyl chemical subunits. ( 44)

**Mechanism of Action (MOA):**

Coenzyme Q-10 is a fats-soluble, diet-like compound this is evidently determined in most tissue of the human frame. It is essential for existence and fitness of every living mobile. The best concentrations are located inside the heart, liver, kidney, and pancreas. The bottom concentrations are determined within the lungs. The human body produces coenzyme Q-10. People can replenish coenzyme Q10 from nutritional assets, inclusive of meats and seafood. The entirety living or once residing consists of coenzyme Q10. In the cell, coenzyme Q-10 is primarily gift inside the mitochondria (forty-50%). It is miles the electron acceptor for the mitochondrial electron transport chain. It is also a cofactor utilized in procedures of aerobic respiration, cardio metabolism, oxidative metabolism, and cellular respiratory. Coenzyme Q10 primary function are as an antioxidant, membrane stabilizer and manufacturing of adenosine triphosphate (ATP) within the oxidative respiration method. As an antioxidant and its position in ATP, coenzyme Q10 offers many therapeutic advantages. Additionally, coenzyme Q10 has been proven to assist hold myocardial sodium-potassium ATPase activity and stabilize myocardial calcium dependent ion channels.

**Current indications and efficacy**

indications	Efficacy
Mitochondrial disorders, inherited or acquired disorders that limit energy production in the cell of the body	In line with clinical research, whilst coenzyme Q10 was given for six months, it seemed to reduce the symptoms associated with mitochondrial Encephalomyopathies. However, the onset is sluggish and took six months to see maximum impact. The FDA has accredited UbiQGel (a selected coenzyme Q10 formation) for mitochondrial Encephalomyopathies, which include MELAS (myoclonic epilepsy with lactic acidosis and stroke-like episodes) syndrome, Kearns-Sayre syndrome, and MERRF (myoclonus epilepsy with ragged red fibers). <sup>(25)</sup>
Congestive heart failure (CHF), in combination with other medications	In line with clinical research (pts with NYHA class III and IV sickness), there's conflicting facts that coenzyme Q10 is powerful on ejection fraction, workout tolerance, cardiac output, and stroke quantity. There is no proof that coenzyme Q10 can help coronary heart failure when taken alone. However, research have proven coenzyme Q10 (doses of 100-200mg/day) to have favorable effects while enthusiastic about heart failure drugs. <sup>(26)</sup>
Chest Pain (angina)	In one clinical examine, coenzyme Q10 confirmed fewer incidents of angina pectoris in comparison to placebo. All the patients in the study all had a fine history of myocardial infarction. The findings endorse that coenzyme Q10 can offer fast protective results in sufferers with AMI if administered within three days of the onset of signs and symptoms. <sup>(27)</sup>
High blood pressure (hypertension)	55% of sufferers who take coenzyme Q10 (doses of 75-360mg/day) have proven to have a 25.9 mmHg reduction in systolic blood strain with 12 weeks of remedy. Research have additionally proven that after coenzyme Q10 is added to different antihypertensives appears to provide a further blood pressure reducing impact and might allow dosage discount or discontinuation of some antihypertensives medicines. 1,9 One study confirmed a median lower in systolic blood strain from 151mmHg to 139mmHg and a median diastolic blood stress decrease from 92mmHg to 84mmHg whilst adding coenzyme Q10 to antihypertensive remedy regimens.

Parkinson's Disease	Coenzyme Q10 at high doses (1200mg/day) appears to slow the progressive deterioration of function in early PD when compared to placebo. <sup>(28)</sup>
Improving the immune system of people with HIV/AIDS	Patients with HIV/AIDS have shown to have a decline in coenzyme Q10. Taking coenzyme Q10 supplement (doses of 200mg/day) have shown to increase plasma levels therefore improve the immune system, which coenzyme Q10 may have immunostimulatory activity. <sup>(29)</sup>
Reducing damage to the heart from doxorubicin (Adriamycin)	Patients receiving doxorubicin have a decline in coenzyme Q10 therefore taking coenzyme Q10 may reduce the cardiotoxicity effects of doxorubicin. 30
Coenzyme Q10 deficiency	Cases of coenzyme Q10 deficiency presenting with symptoms of weakness, fatigue, and seizures, coenzyme Q10 supplement have improved those symptoms. 31
Huntington's disease	Studies have shown coenzyme Q10 does not slow the progression of Huntington's Disease. Some researchers have suggested it may take higher doses to show a clinically significant effect. <sup>32</sup>
Improving blood sugar control in people with diabetes	Studies have not shown to improve glycemic control or reduce insulin requirements in Type 1 or Type 2 diabetic patients. <sup>33</sup>
Improving exercise performance	Studies have shown that coenzyme Q10 does not improve aerobic power in athletes. More research is needed. 14
Dental disease, when applied directly to the teeth and gums	Insufficient data. Need more evidence.
Breast cancer	There's primary evidence that coenzyme Q10 might be helpful in advanced breast cancer along with surgery and conventional therapy plus other antioxidants and omega-3 and omega-6 fatty acids. <sup>35</sup>
Migraines	One studied showed coenzyme Q10 reduced the number of days with migraine and reduce migraine frequency when compared to baseline. <sup>36</sup>

Table No.1- Indication and Efficacy

### Food Sources of Coenzyme Q10

CoQ10, can be produced through chemical synthesis, extraction from organic tissues (plants and animal) and microbial fermentation (37). Inside the wake of environmental consciousness, the chemical alternatives became least suitable because of inherent uses of solvents and chemical substances within the manner (38). Plant and Animal assets of CoQ10 CoQ10 is clearly present in small quantities in a wide variety of foods, but is excessive in animal meat organs which includes heart, liver and kidney, red meat as well as soy oil, sardines, mackerel, and peanuts. The highest content material is discovered in meat and fish tissues and viscera due to their high stages of mitochondria (39). Furthermore, presence of CoQ10 in bee pollen become investigated (40). The effects of CoQ10 contents in animal organs and diverse flora are overviewed in table No 2

Food		CO Q10 concentration (mg/kg)
Beef	Heart	113
	Liver	39 – 50
	Muscle	26 – 40
Pork	Heart	12 - 128
	Liver	23 – 54
	Muscle	14 – 45
Chicken	Breast	8 – 17
	Thigh	24 – 25
	Wing	11
	Sardine	5-64

<b>Fish</b>	Red flesh	43-67
	White flesh	11-16
	Salmon	4-8
	Tuna	5
<b>Oils</b>	Soyabean	54 – 280
	Olive	4 – 160
	Grapeseed	64 – 73
	Sunflower	4 – 15
	Canola	64 - 73
<b>Nuts</b>	Peanut	27
	Walnut	19
	Sesame seed	18 - 23
	Pistachio	20
	Hazelnut	17
	Almond	5 - 14
<b>Vegetables</b>	Parsley	8 - 26
	Broccoli	6 - 9
	Cauliflower	2 - 7
	Spinach	Up to 10
	Chinese cabbage	2 - 5
<b>Fruit</b>	Avocado	10
	Blackcurrant	3
	Grape	6 - 7
	Strawberry	1
	Orange	1 - 2
	Grapefruit	1
	Apple	1

**Table 1. Overview of CoQ10 contents in various foods (41)**

## **The Role Of Coenzyme Q10 in Hair Growth (45)**

### **It Boosts the Production of Keratin**

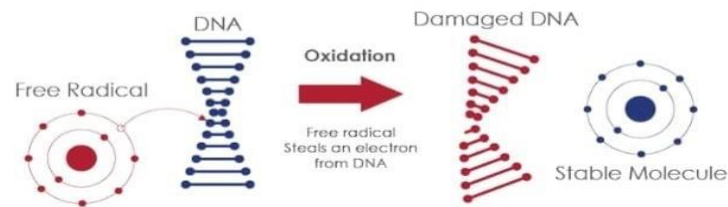
Coenzyme Q10 (Ubiquinol) has an anti-ageing effect on hair health, as it boosts the process of gene expression which is involved in the synthesis of keratin (a protein found in hair), especially the proteins that are compromised by the ageing process.

A clinical trial was conducted to evaluate a coenzyme Q10-enriched tonic formula, which was used every day, over the course of four days, by a group of volunteers over the age of 40. The results showed a proliferation of the protein keratin in the hair roots of the participants who had used the shampoo.

### **2: It works as an antioxidant**

Coenzyme Q10 in the form of Ubiquinol is also a strong antioxidant, which neutralizes the free radicals that cause oxidative damage to the body's DNA and cells.





A free radical stealing an electron from a DNA molecule. This damages the DNA.

**Figure No.6: Oxidative damage to the body's DNA and cell**

### **3: It Plays an Important Role in the Metabolism of Energy**

A lack of Coenzyme Q10 can affect the production of ATP, because coenzyme Q10 plays an important part in the electron transfer process in aerobic cellular respiration. This is where cellular energy in the form of ATP (adenosine triphosphate) is synthesized. If suitable levels of ATP are not met, the body will use testosterone to produce cellular energy.

This results in the production of DHT (dihydrotestosterone), which has been proven to cause hormone-related hair loss. Look at this clinical trial which discusses the role of DHT in pattern baldness (androgenic alopecia) in humans.

### **4: It Increases Oxygen Flow to the Scalp**

A sufficient supply of oxygen is required to formulate cellular energy in the structure of ATP and a lack of oxygen in the blood results in the weakening of the hair follicles.

## **Conclusion**

Coenzyme Q10 (CoQ10) is an endogenous compound that plays a crucial role in energy production in cells. It is also known for its antioxidant properties, which help protect cells from damage caused by harmful molecules called free radicals. While CoQ10 has several potential health benefits, including its role in maintaining skin health and supporting overall body functions, there is limited scientific evidence for its direct role in promoting hair growth.

Hair growth is a complex process influenced by factors such as genetics, hormones, diet, and general health. While some studies suggest that CoQ10 may have a positive impact on hair health due to its potential antioxidant and energy-generating properties, the evidence is not strong enough to say with certainty that CoQ10 directly promotes hair growth.

## **Conflicts of Interest**

The authors have stated that there is no Conflicts of Interest

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