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ABSENCE OF H_2O_2 BREAKDOWN IN HUMAN HAIR MEDULLA IMPLICATIONS IN FOLLICULAR MELANOGENESIS

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Abstract

The purpose of this manuscript is to introduce the absence of H2O2 decomposition in the human hair follicle medulla. This absence is attributed to an absence of the antioxidants that are essential for the elimination of reactive oxygen species generated during cellular respiration. The present assumption is that the human hair follicle follicular melanogenesis (FM) involves sequentially the melanogenic activity of follicular melanocytes, the transfer of melanin granules into cortical and medulla keratinocytes, and the formation of pigmented hair shafts. The introduction of an airborne gradual hydrogen peroxide (H2O2) molecules transfer into water, has allowed for the slow down of H2O2 decomposition speed when contacting human tissue. The usual explosive reaction commonly seen has been avoided; and previously unseen details of the H2O2 breakdown anatomical locations within the human hair follicle reaction can now be detected. Dynamic video-recordings show for the first time H2O2 decomposition occurring in the cortical and cortex areas. Published evidence links cellular H2O2 breakdown and metabolism. A new paradigm is herein introduced where the human hair medulla is excluded from H2O2 breakdown, thus inferring the absence of metabolic activity from FM.

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Keywords: Folliclular Melanogenesis; Injured Follicle; H2o2 Reaction Speed; Follicle Cuticle; Follicle Cortex; Follicle Medulla.

Glossary:

1) Antioxidants= Enzymes responsible for the breakdown of toxic substances such as H2O2
2) Cuticle, Cortex, Medulla= Innermost tissue layers of hair follicle.
3) H2O2= Hydrogen Peroxide
4) H2O2 breakdown= Decomposition of H2O2 molecule into Oxygen and Water.
5) Melanin= Dark brown to black pigment occurring in the hair, skin, and iris of the eye in people and animals. It is responsible for tanning of skin exposed to sunlight.
6) Melanogenesis= The formation of Melanin

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1. Introduction

The purpose of this communication is to demonstrate for the first time dynamic evidence (via video-recordings) challenging the anatomical sites identified as to where melanogenesis takes place in the human follicle (1). Exogenous (H2O2) molecules decompose when penetrating an injured hair follicle; this breakdown is caused in sites of active metabolism. This manuscript re-introduces a desktop optical microscopy technique (2) developed for the slowing of H2O2 decomposition speed. This allowed for the demonstration (video-recordings) that H2O2 breakdown occurs in the cortical/cortex areas of the hair follicle. There is a noticeable absence of activity (read metabolism) in the medulla (3).

The Human Hair Anatomy

As shown (Figure 1) for the purpose of this presentation, the human hair is anatomically divided into two main components. The inner anatomy of the hair follicle can be appreciated. The image below was obtained by immersing in vitro a scalp human hair (n=2) from a blonde person in liquid Potassium Ferrocyanide (4,5). Attempts to duplicate the experiment failed in gray or dark hairs.

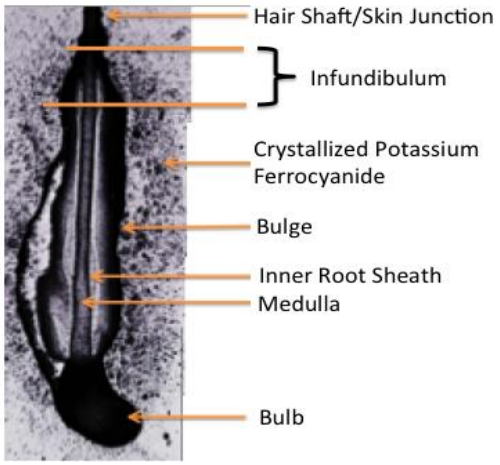

Figure 1: Human Hair Follicle Structures.

2. Materials and Methods

The Injured Hair Root Experiments

Hydrogen Peroxide when poured into a wound emits bubbles. These bubbles are as result of the H2O2 breakdown by the protein enzyme catalase abundantly present in tissue. This reaction causes the H2O2 to decompose into water and oxygen. The hair has been classified as a mini organ with its own circulation, nerve innervation and cellular divisions (6), this entails cellular respiration inducing H2O2 decomposition. Cell respiration entails the elimination of toxic substances, one of them being the endogenously produced H2O2 (7,8). Experimentally, when drops of H2O2 are in contact with plucked hair follicles on a glass slide, there is an explosive reaction seen due to H2O2 breakdown into water and oxygen molecules; therefore this maneuver obscures any time related details of the reaction (Figure 2). In other words, the visual dynamics identifying where the H2O2 molecules travel when penetrating the tissue are difficult to track; this unless the reaction is slowed down. This author theorized that by slowing the H2O2 decomposition reaction, details not

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previously recorded could be documented. Areas where oxygen bubbles are created would then infer the presence of follicular melanogenesis.

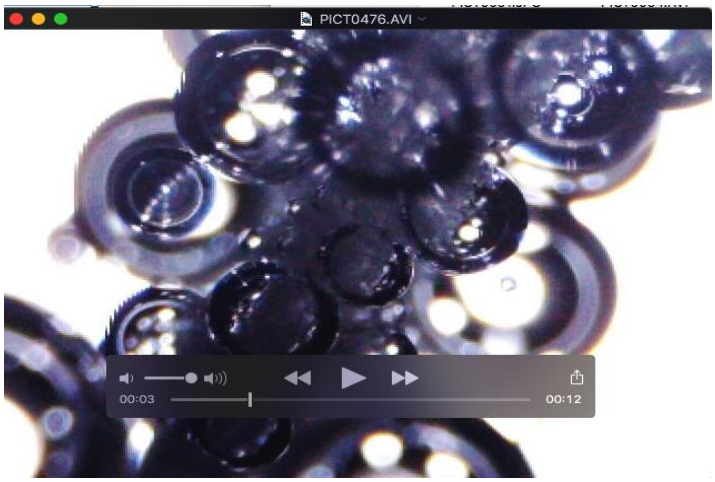

Figure 2: Typical explosive reaction observed when the H_2O_2 molecule is in contact with the enzyme catalase. Notice the lack of details obscured by the presence of numerous air bubbles. Please refer to the link:https://youtu.be/c-wrQdPK2pk

The Airborne Technique for H2O2 Molecules Titration

In a previous publication (3), a technique utilizing a slide assembly allowed for the gradual airborne transfer of H2O2 molecules into adjacent pure water (Figure 3).

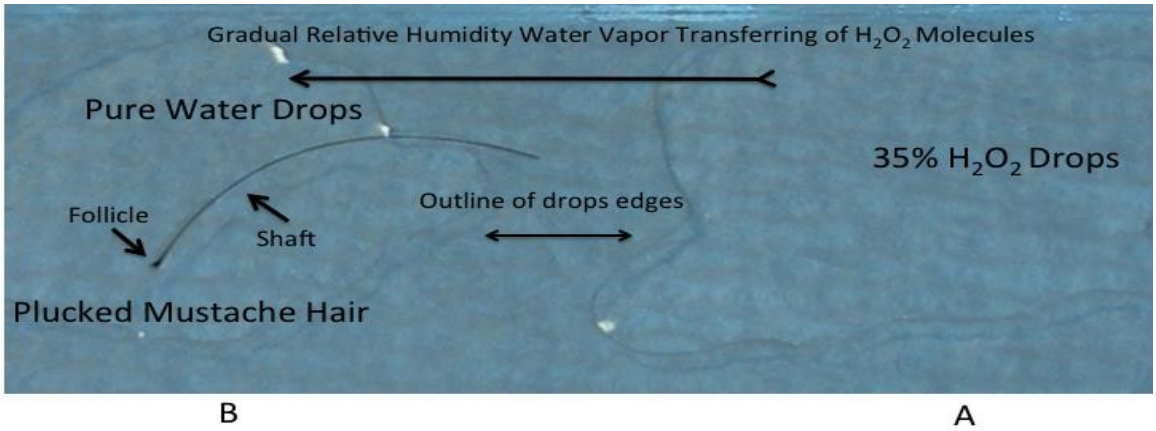

Figure 3: A= Drops of 35% H_2O_2 on right side of glass slide B= Plucked mustache hair in pure water drops Long black arrow showing gradual transfer of H_2O_2 molecules penetrating pure water drops.

3. Discussion

Identifying Sites Where H2O2 Molecules are Decomposed When Penetrating an Injured Hair Follicle

In this manuscript dynamic images (video-recordings) document that in the injured hair follicle, H2O2 molecules migrate between the cuticle and the cortex (Figures 4,5,6,7 plus supplementary video-recordings). All figures presented show H2O2 decomposition occurring in the cuticle and

cortex layers of the follicle. The lack of H2O2 decomposition infers a lack of antioxidant presence, thus absence of metabolic activity (read metabolism) (3). Due to its potential effect on melanogenesis these findings support the published theory that endogenous H2O2 produced in millimolar amounts in the hair follicle could be a factor in senile gray hairs. In other words, as we age, our antioxidant mechanism is impaired, thus allowing for hair greying to occur. As aforementioned, the figures and video links below, demonstrate that H2O2 decomposition occurs between the cuticle and the cortex.

Present Paradigm

These findings contradicts the 2005 published paper by Slominski, A. where is stated that "Follicular melanogenesis (FM) involves sequentially the melanogenic activity of follicular melanocytes, the transfer of melanin granules into **cortical** and **medulla** keratinocytes, and the formation of pigmented hair shafts". (1).

Proposed New Paradigm

Instead, the data herein presented is in agreement with the physical location of melanin found by pathologists as stated: "The cortex of the hair shaft is located between the hair cuticle and medulla and is the thickest hair layer. It also contains most of the hair's pigment, giving the hair its color. The pigment in the cortex is melanin, which is also found in skin. The distribution of this pigment varies from animal to animal and person to person. In humans, the melanin is primarily denser nearer the cuticle whereas in animals, melanin is primarily denser nearer the medulla" (9); also confirmed by a forensic pathologist "Human hair has a narrow medulla and a thick cortex and the reverse is true for animal hair….In human hair the medulla is narrow and the pigment is concentrated at the periphery of the cortex" (10). The dynamic recordings as presented in four different experiments demonstrate that the H2O2 molecules are broken down between the cuticle and the cortex.

Medical Implications

The technique and results presented could have utility in evaluating hair losing syndromes, such as Alopecia Areata and possibly Telogen Effluvium (11,12) How? By evaluating follicular melanogenesis activity in these syndromes. Additional research is warranted.

Summary

Labeled microphotographs of video-frames are presented. Video-recordings are also available to the reader. By analyzing these images, the presence of oxygen bubbles indicating follicular melanogenesis are now observed occurring in the cuticle/cortex area of the human hair follicle; instead of the cortex/medulla as previously reported. The findings herein presented are supported by independent pathologist. Also confirmed is the theory that oxidative stress (H2O2) is responsible for senile greying (13).

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Figure 4 Distal hair follicle segment. Transverse cut made with razor blade. Segment in water drop adjacent to 35% H2O2 drops. Magnification X10.

Notice H2O2 decomposition in injured area. Greater details in Figure 2 below
Supplementary video at: https://youtu.be/VF6VuBZX3uE

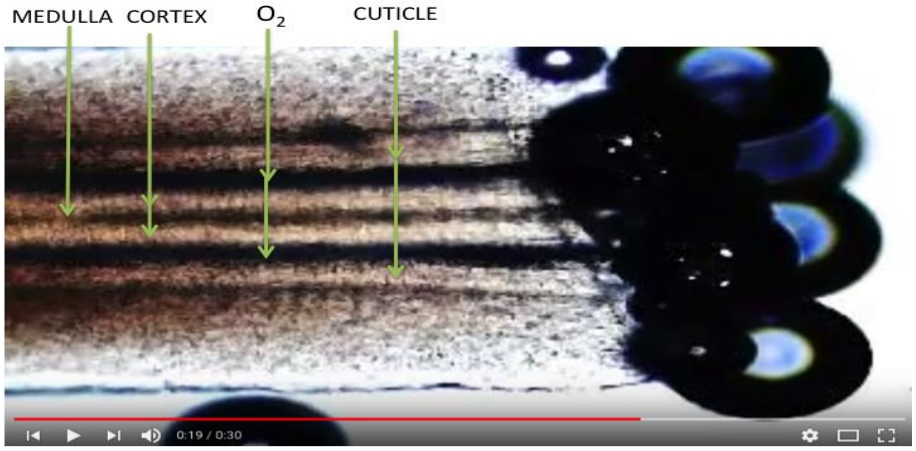

Figure 5: Amplified Figure 1 above. Cut human hair follicle showing H2O2 decomposition between Cortex and Cuticle. Video-recording shows O2 bubbles flowing from left to right. Magnification X40 Supplementary video at : https://youtu.be/VF6VuBZX3uE

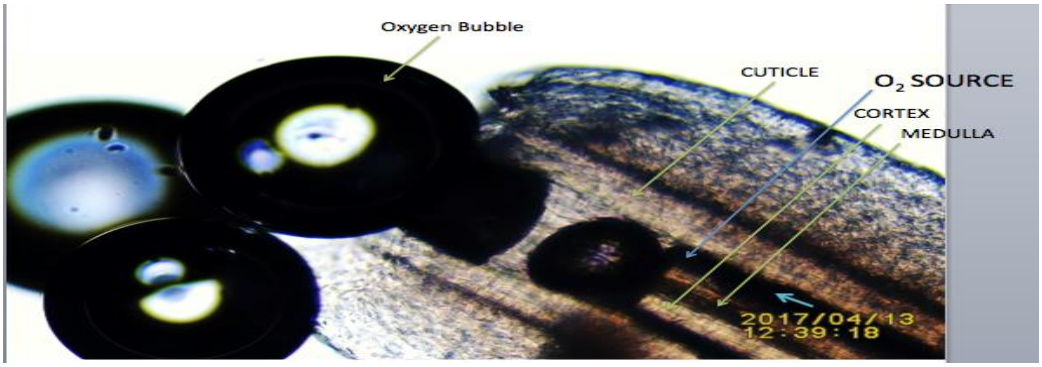

Figure 6: Transverse cut human scalp hair follicle immersed in pure water and near drops of 35% H_2O_2. The medulla had retracted into the hair structure. Microphotograph of still video-frame from video-recording showing gas bubbles slowly flowing bilaterally between the cuticle and cortex. Blue arrow points at glass flow. Magnification X40. Additional flow dynamics can be seen in supplementary video-recording by https://youtu.be/qYap65vQ8RQ

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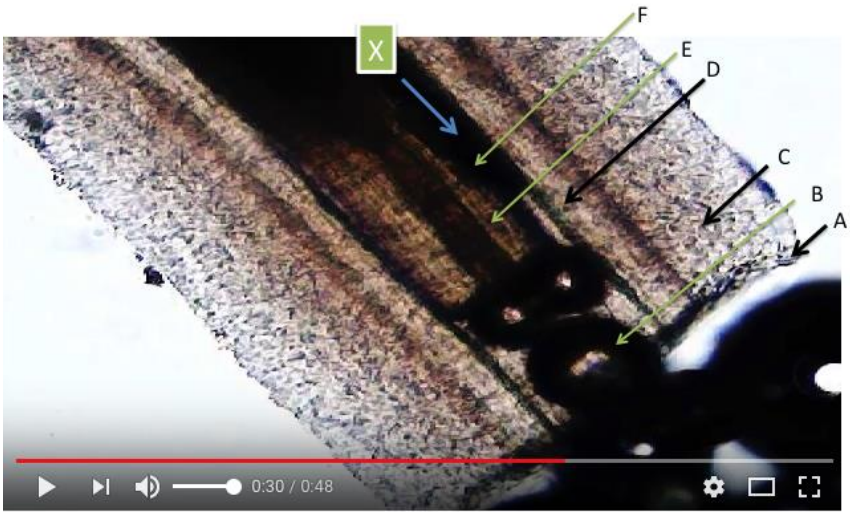

Figure 7: Human scalp hair follicle immersed in pure water and near drops of 35% H_2O_2. Microphotograph of still video-frame from video-recording showing gas bubbles emitted. A= Transected line B= Bubble C= External Root Sheath D= Cuticle E= Cortex F= O_2 source X= Direction of gas flow (Between Cortex and Cuticle). Details are appreciated due to slower H_2O_2 decomposition accomplished by a low H_2O_2 substrate concentration. Magnification X40. Supplementary video at: https://youtu.be/w2-tE57Ok_o

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