

## EDITORIAL

### PIGMENTATION OF THE BLACK SKIN IN HEALTH AND DISEASE

Appearing in this issue of the Journal are two articles which deal with pigmentation abnormalities of the black skin. This editorial comment is designed to provide some background information, and thereby facilitate understanding and appreciation of the two articles by all readers.

The colour of human skin is due predominantly to the presence of the biological brownish black pigment melanin in the epidermis. Other pigments such as carotenoids (yellow), oxyhaemoglobin (red), reduced haemoglobin (blue) which play relatively insignificant roles when melanin pigmentation is heavy, assume some significance in individuals who lack melanin completely, such as albinos, or have very little of it, (very fair Caucasians) in whom the skin assumes a pink colour. For practical purposes therefore, human skin pigmentation means melanin pigmentation. The function of melanin is protection of the individual against the harmful effects of ultra-violet light. Light is essential for vital biological functions such as Vitamin D synthesis and vision, however the Ultra-Violet B [UVB] part of the spectrum (wavelength 290-320nm) is capable of destroying tissue leading to sunburn, premature ageing and neoplastic degeneration.

### BIOSYNTHESIS AND DISTRIBUTION OF MELANIN

Melanin is produced by the melanocytes which are specialised dendritic cells derived from the embryologic neural crest and found in adult life at the dermo-epidermal junction and around hair bulbs. The melanocytes synthesise the enzyme tyrosinase which is incorporated into an organelle, the melanosome which is also elaborated within the melanocyte. The melanosome provides the framework on which the tyrosinase oxidises the amino acid tyrosine in stages through dihydroxyphenylalanine (DOPA), to dopaquinone, which polymerises to form melanin which in turn melanises the melanosomes. It is the presence of melanized melanosomes dispersed evenly or unevenly, sparsely or heavily in the keratinocytes at the basal layer or sometimes (especially in dark-skinned persons) in all layers including stratum corneum that produces the characteristic pigmentation in each individual.

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## RACIAL VARIATION OF SKIN COLOUR

The variation of skin colour among the various races of mankind is a function of the genetically determined level of activity of the melanocyte and pattern of distribution of melanosomes in the epidermis.<sup>3</sup> The differences in racial pigmentation are not due to variation in numbers of melanocytes; the melanocyte count was found to be identical in corresponding skin areas in all races.<sup>1,2,3,4</sup> Racial differences in pigmentation rather depend on rate of production of melanized melanosomes, their size, structure and distribution pattern in the keratinocytes.<sup>1,2,3,4</sup> Generally melanocytes, in the darker races produce the enzyme tyrosinase at a faster rate, resulting in more and larger (0.6-1nm singly dispersed melanized melanosomes) than in the lightly-pigmented races whose melanosomes are smaller (0.3 x 0.5nm) and usually aggregated, (3 or 4 in membrane-bound) phagosomes containing acid phosphatase and having lysosomal activity for melanosome degradation.<sup>4</sup> In lightly pigmented skin, melanosome degradation limits melanosomes to basal keratinocytes only. On the contrary, degradation does not occur in Negroid melanosomes which therefore get to the surface of the skin (stratum corneum) intact.<sup>1,2,3</sup>

## ENDOGENOUS CONTROL OF MELANOCYTE FUNCTION

Tyrosinase is the rate-limiting enzyme of pigment production. Gene-controlled absence of the enzyme results in albinism which is a recessive trait. Tyrosinase belongs to the phenolase group of enzymes which are copper-proteins found in plants and animals.<sup>5</sup> The copper molecule is essential for the function of tyrosinase,<sup>5,6</sup> therefore any substance capable of removing copper from the system inhibits the action of tyrosinase and slows down the above reac-

tion. Sulphydryl (SH) substances have a high affinity for copper, thus rendering them potential inhibitors of tyrosinase activity.<sup>5,6,7,8</sup> Variation of the level of SH activity in the cells serves as the mainstay of control within the melanocytes. When the SH substance in the cell-pool decreases, tyrosinase inhibition is released and hyperpigmentation results.

Conditions which decrease SH levels in the cells such as Vitamin B<sub>12</sub> deficiency,<sup>9,10</sup> folate deficiency,<sup>11,12</sup> glucose-6-phosphate dehydrogenase (G-6-PD) deficiency,<sup>9,10</sup> SH-binders, sunlight, UVB, and Ultra-Violet A [UVA, wavelength 320-400nm], have the potential of freeing tyrosinase from SH-inhibition and thereby causing hyperpigmentation. On the other hand, situations which increase SH-levels in the cells such as ingestion of SH-producing substances, thiol compounds, thioureas, cysteine and glutathione increase copper-binding, with consequent inhibition of tyrosinase activity leading to hypopigmentation. Heavy metals such as mercury, gold and silver which are capable of displacing copper from tyrosinase, also inhibit tyrosinase activity and produce hypopigmentation. This is the basis of the banned mercury-containing soaps which for a long time were used by Ghanaian women to bleach their skin.

## HORMONAL CONTROL OF PIGMENTATION

Although pituitary hormones such as melanocyte stimulating hormone (MSH), adrenocorticotrophic hormone (ACTH), and ovarian hormones may control cutaneous pigmentation during the developmental stages and also under certain physiological (pregnancy) and pathological conditions in man, there is no evidence that day to day physiological control is influenced by hormones in man. The hyperpigmentation which accompanies Addison's disease and thyrotoxicosis is due to increased MSH ac-



tivity. Pregnancy is invariably associated with significant hyperpigmentation of the nipples, areolae, linea nigra, and sometimes the face even long after the end of the pregnancy.

## **VARIATION OF SKIN COMPLEXION IN HEALTH**

The complexion of an individual is an important part of his self-image and his identity which relatives and close associates grow to accept.

The genetic constitution determines a minimum intrinsic or basic pigmentation which is constant for each individual. The intensity of the basic pigmentation seems to be a function of adaptation to ambient ultra-violet light, for generally speaking, indigenous people who live near the equator are heavily pigmented. Furthermore, there exists a graduated decrease in skin pigmentation as one moves further from the equator, culminating in very lightly complexioned individuals at the poles. Exceptions to the above rule are accounted for by immigration of Caucasoids from Europe to the tropics, and Eskimos from South Central Asia to Arctic Regions.

Over and above the genetically determined intrinsic or constitutive pigmentation, the healthy individual can acquire more pigmentation under the influence of various endogenous (hormonal, and metabolic) and exogenous (environmental, physical and chemical) agents. The extent to which endogenous and exogenous factors can influence, i.e. increase pigmentation above the constitutive level is itself genetically determined. Individuals whose genetic constitution is geared to a high level of pigment production are more responsive to the agents; in other words the darker the original skin colour, the more susceptible an individual is to inducible or facultative pigmentation, regardless of the inducing agent.

Factors tending to increase pigmentation over and

above the constitutive level under physiological conditions are ambient UVA and UVB, oestrogens, and melanocyte stimulating hormone. On the other hand, factors tending to decrease pigmentation to the constitutive level are lack of sunlight and pigment loss through normal/physiological imperceptible desquamation of superficial parts of stratum corneum. The final complexion represents the dynamic equilibrium between pigment gain and pigment loss. Thus, day to day variation occurs in all individuals, especially in the dark-skinned races in whom melanocyte activity is at a high level.

## **CHANGES IN SKIN PIGMENTATION IN DISEASE**

Whereas minor modifications of complexion induced by climatic conditions such as acquired bleaching of black skin following prolonged sojourn in less sunny climes, and tanning of white skin in the tropics, are acceptable as normal physiological day to day variations, major changes entailing generalised or localised, regular or irregular patches of severe increased or decreased pigmentation, are not acceptable as normal, but rather considered as diseases which require treatment.

Skin hyperpigmentation is regularly found in Ghanaian patients following inflammatory conditions, regardless of aetiology which may be immunologic/allergic, e.g. atopic eczema, infective or even induced by direct physical or chemical assault. Other disease processes constantly associated with hyperpigmentation in our environment include malnutrition/kwashiorkor, Addison's disease, ACTH/MSH producing tumours, pregnancy, and oestrogen therapy. At the other end of the spectrum, conditions associated with absolute lack of pigmentation are albinism and vitiligo which also manifests as localised large and small areas of complete pigment lack. Other common conditions associated with complete, or more commonly, partial loss of pigment or hy-

popigmentation, include certain superficial fungal infections, tuberculoid leprosy, Addison's disease, hypopituitarism, kwashiorkor and topical exposure to certain chemicals and pharmacological agents such as hydroquinone and topical steroids.

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