Human skin pigmentation processes

Human skin pigmentation can be regulated by various physiological factors such as hormones, peptides derived from pro-opiomelanocortin (POMC) and also by the -melanocyte-stimulating hormone (-MSH) via the melanocortin-1-receptor (MC-1R) pathway. A further factor believed to have a regulatory mechanism in human skin pigmentation is a key enzyme known as tyrosinase.

Melanocytes also have a role in determining and regulating the human skin pigmentation. Melanocytes form two types of melanin these are eumelanin and pheomelanin. The amounts of these two types present determine the colour of the hair and skin. For those who have mostly eumelanin have will have darker skin. Eumelanin also is very important as it is important in helping protect the skin against damage that is caused by UV radiation. Whereas pheomelanin does not protect against UV radiation so those people with more pheomelanin are in risk from damage to the skin by UV radiation. Also those with more pheomelanin tend to have lighter skin.

The type of melanin that is produced by the melanocytes is controlled by the MC-1R. The MC-1R is a receptor which can be found on the surface of the melanocytes which are specialised cells which produce melanin via a process known as melanogenesis. This is a G coupled protein which binds to melanocortin peptides such as ACTH and a-MSH and is involved in regulating human skin pigmentation.

Each of these factors affects human skin pigmentation in different ways.

The human skin is thought to be a local source and a target for POMC The many peptides that are derived from POMC such as (-MSH) and

adrenocorticotropic (ACTH) as well as POMC itself which are believed to have an important role in the regulation, and control of human skin pigmentation, by acting on the melanocortin-1 receptor (MC-1R) and also regulation of the melanocytes. These peptides and hormones are produced via the enzyme known as prohormone convertases (PCs) which cleave the POMC at different points. Different POMC derived peptides produced act on specific melanocortin receptors this is dependant on the tissue.

POMC is involved in the stimulation and increase in melanogenesis and the dendricity in human pigment cells. Mutations of the POMC genes in patient s have lead to pale skin and other problems such as red hair and obesity. This change in the hair colour and pale skin is believed to be because there is a lack of ligands for MC-1R (kligman AM 1959, Krude H et al). Also MC-1R polymorphisms are also thought to cause pale skin because they reduce the MC-1R activity. Administration of ACTH and -MSH to humans has shown a significant darkening of the skin. If the ACTH is administrated for a prolonged period of time this can lead to hyperpigmentation. Excessive concentrations of POMC can be detected in adission’s and nelson’s syndrome which can also lead to hyperpigmentation. POMC peptides are thought to cause stimulation of melanocyte tyrosinase and melanogenesis. Finally at high concentrations POMC can lead to an increase in melanin and the further effect is to help increase the dendricity of human epidermal melanocytes.

A further regulator of human skin pigmentation could be B-endorphin (B-end). There are several observations which have stated that (B-end) may have a role in regulating human skin pigmentation. Studies have shown that after UVA exposure there is an increase in (B-end) which has been

associated with the pigmentation of the skin increasing (levins et al, 1983; Belon, 1985). However it has been recently discovered that exposure to UVA, UVA-1 OR UVB radiation weather once or repeatedly does not lead to an increase in the levels of B-end in the plasma (Wintzen et al, 2001).

The precursor of B-end which is B-lipotropic hormone (B-LPH) is said to stimulate melanogenesis in amphibians and in sheep (Lohmar and Li, 1968). High levels of B-LPH have been generalised with humans having hyperpigmentation. Research has found that the B-END/μ-opiate receptor system is important in regulating melanocytes because of its ability to up regulate melanocyte dendricity, proliferation and also pigmentation.

B-end acts opposite to ACTH and a-MSH which stimulate melanogenesis by acting on the MC-1R and activate cAMP messenger system (Busca and Ballotti, 2000). The B -END works by inhibiting this signalling pathway. Research has proposed that the B-end/μ opiate receptor may be acting via the protein kinase C inhibitor which causes the tyrosinase to be activated directly and also stimulates melanogenesis.

B-end has a role in human skin pigmentation however the mechanism is different from other peptides such as ACTH and a-MSH because B-end mechanism is independent of the MC-1R which is used by the ACTH and a-MSH. B-end is a potent modifier of melanocyte phenotype this is achieved by upregulating melanocyte dendricity, proliferation and melanogenesis.

To conclude there are many different methods of regulating human skin pigmentation and also different pathways via which different hormones and peptides affect human skin pigmentation. One of the major regulators in

human skin pigmentation are peptides derived from POMC such as ACTH and a-MSH which are stimulated by the MC-1R pathway and also involves the cAMP messenger system. Research has shown that there are a combination of factors mostly internal factors which regulate human skin pigmentation however there is some evidence that external factors such as UV radiation can also cause changes in the regulation of human skin pigmentation.