

# Hypothalamus-Pituitary-Adrenal Axis, Hair Cortisol, Chronic Stress, Metabolic Syndrome, and Mindfulness

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## Background Information

Over the past 60 years, there has been an exponential expansion in the field of neuroendocrinology. The HPA (Hypothalamus-Pituitary-Adrenal) Axis is affected by both internal physiological stressors (cytokines, hypoxia, macromolecules, etc), and by external stressors (source of anxiety, fear, etc), which threaten the organism's homeostasis. Cortisol binds to cortisol receptors throughout the body. The hormone receptor complex is to be found in the nucleus of the cells, where it binds to DNA (docking). The consequences of this bond vary considerably. In some cells cortisol can induce some genes and repress others. When the HPA Axis is overactive, the amount of cortisol in the nucleus of the cells may increase tenfold.

Glucocorticoids influence many functions of the central nervous system, such as arousal, cognition, mood and sleep, the activity of intermediary metabolism, the maintenance of a normal cardiovascular tone, the activity and quality of the immune system and of the inflammatory reaction [1].

Professor Nemeroff has emphasized the opportunity of "early intervention in at risk individuals". He suggests that individuals who have been exposed to untoward early life stress, can be considered an "at risk population".

Research has shown that Chronic Stress can lead to progressive dysregulation of the HPA Axis. There seems to be a gap between the onset of the dysregulation of the HPA Axis and the onset of the different illnesses/syndromes. This seems to be "a window of opportunity".

Stan Van Uum, et al. mention that Hair Cortisol levels are being increasingly used in a variety of pathological situations, because it can provide a long term measure of systemic cortisol exposure [2]. Research has shown that it can be used as a biomarker of chronic stress.

The HPA Axis is fundamentally a dynamic system (Rachel Yehuda). Hair Cortisol levels would facilitate longitudinal studies,

as it would allow monthly cortisol levels for a period of 3-4 months at a time. It has been suggested that increased activity of the HPA Axis, with increased levels of glucocorticoid hormones, may contribute to the development of the Metabolic Syndrome (MetS).

Stalder, et al. has shown that even physiological differences in long term cortisol secretion, as assessed in hair, show relevant relationships with Metabolic Syndrome (MetS) [3]. The Metabolic Syndrome involves a cluster of cardiometabolic abnormalities, including hypertension, abdominal obesity, hyperglycemia, dyslipidemia. New evidence has emerged on early life stress induced metabolic derangements. Early life stress can alter the expression of the genes in peripheral tissues, such as glucocorticoid receptor and 11- beta hydroxysteroid dehydrogenase.

Margaret J. Morris, et al. proposes that interactions between altered HPA Axis activity and liver 11-beta hydrogenase modulates both tissue and circulating glucocorticoid availability, with adverse metabolic consequences.

David Cresswell and Emily K. Lindsay propose that Mindfulness can have a Stress Buffering effect. Well controlled studies have suggested that Mindfulness-training interventions can improve a broad range of mental and physical health outcomes (eg HIV pathogenesis, depression relapse, inflammation) [4]. Also, Cresswell and Lindsay offer an evidence based biological model of mindfulness. This suggests that mindfulness may alter neural stress- processing dynamics. In high stress participants, Mindfulness can reduce SAM (Sympathetic-adrenal medullary) or HPA Axis reactivity, and help normalize dysregulated stress signalling in these systems.

Mindfulness is a capacity to attend with awareness, to what is happening in one's present moment experience, and to monitor it with acceptance. Mindfulness has been shown to alter different stress processing pathways in the brain. It increases the recruitment of prefrontal regulatory regions that may inhibit activity in stress processing regions ("top-down regulatory pathway"). It may also have direct effects on modulating the reactivity of stress-processing

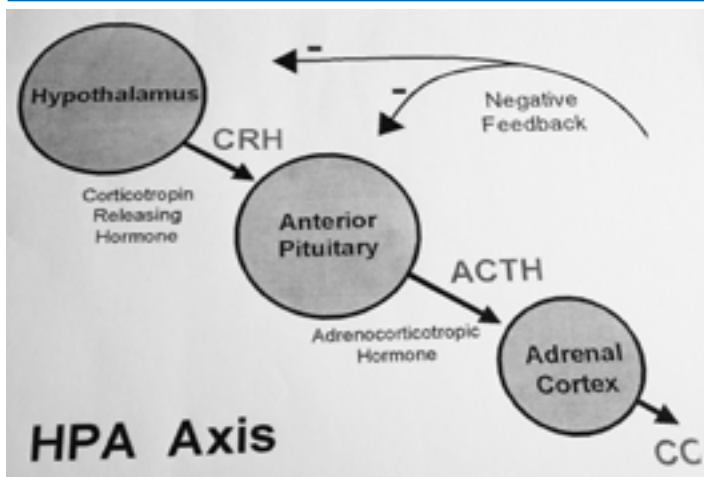


Figure 1: HPA Axis.

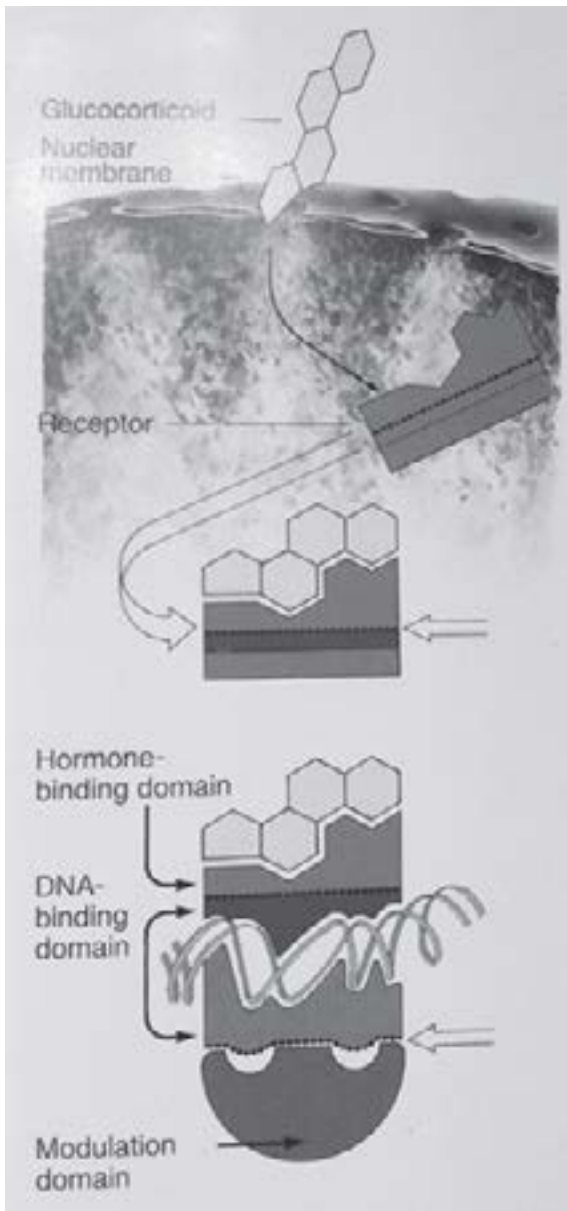


Figure 2: Scheme of the interaction of a steroid hormone with its specific receptor.

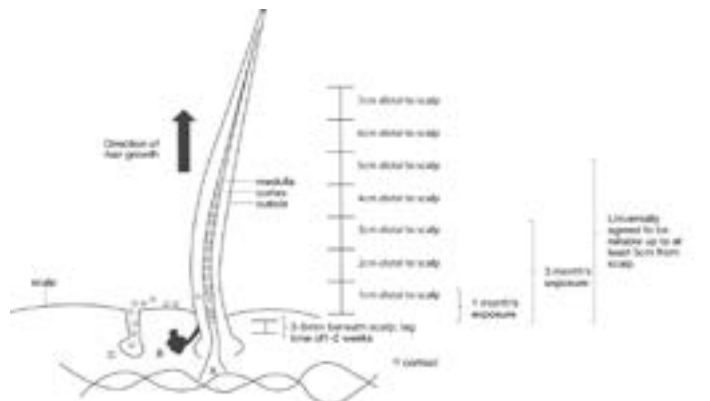


Figure 3: Proposed mechanisms for incorporation of cortisol into hair via blood (A), sebum (B), and sweat (C).

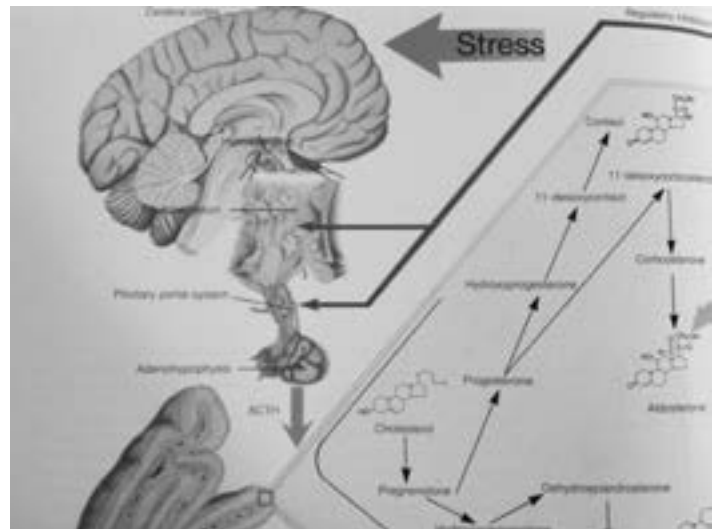


Figure 4: Cortisol production during stress (Breckwoldt, Neumann, Brauer, "Exempla Endocrinologica, 1994).

regions ("top-down regulatory pathway"). It may also have direct effects on modulating the reactivity of stress-processing regions ("bottom-up approach"). Mindfulness also reduces the reactivity of central-processing regions responsible for signalling peripheral stress-response cascades (eg: the amygdala, etc). It would be interesting to study the HPA Axis, using Hair Cortisol levels in "Vulnerable individuals" before and after Mindfulness training, and compare to control group. Also, to measure the cardio metabolic parameters. In particular, it may be helpful to study how mindfulness training can affect the different stages of sleep, as research has shown that the slow wave of sleep can help modulate the HPA axis [5].

- Would Mindfulness training be a helpful adjunct therapy to help modulate the HPA Axis and improve mental and physical health?
- Would Mindfulness training help to empower individuals to help themselves prophylactically to keep well?
- Would Mindfulness training protect "vulnerable individuals" by helping to modulate the HPA Axis?

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## References

1. Chrousos GP, Kino T (2007) Glucocorticoid action networks and complex psychiatric and/or somatic disorders. *Stress* 10: 213-219.
2. Gow, Thousons S, Rieden M, Van Uum S, Koren G (2010) An Assessment of cortisol analysis in hair and its clinical applications. *Forensic Science International* 196: 32-37.
3. Stalder T, Kirschbaum C, Alexander N, Bornstein SR, Gao W, et al. (2013) Cortisol in hair and the metabolic syndrome. *J Clin Endocrinol Metab* 98: 2573-2580.
4. Cresswell JD, Lindsay EK (2014) How does Mindfulness training Affect Health? A Mindfulness-Stress-Buffering Account. *Current Directions in Psychological Science* 1-7.
5. Breckworld M, Neuman F, Bräuer H (1994) *Exempla endocrinologica, Pictorial atlas of the physiology and morphology of the endocrine system* 1.

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