

Thyroid: Source or Scapegoat

How Your Thyroid Affects Your Health & Metabolism
...Or Vice-Versa

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Metabolism

- Define Metabolism
 - The sum of the physical and chemical processes in an organism by which its material substance is produced, maintained, and destroyed, and by which energy is made available.
 - Anabolism requires energy in, builds complex tissue
 - Catabolism releases energy, involves the breakdown of complex tissue to simpler components.

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Active Metabolism

- Hormonal regulators of metabolism
 - Thyroid Hormone: Triiodothyronine - T3
 - Estrogen/progesterone
 - DHEA
 - Growth Hormone
 - Testosterone
 - Cortisol
 - Leptin
 - Epinephrine / Norepinephrine
 - Non-hormonal cellular cytokines

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Metabolism, Basal metabolism

- The basal metabolic rate (BMR) is a measurement of energy required to keep the system functioning at rest.
- Measured in calories, metabolic rates increase with exertion, stress, fear, and illness
- Thyroid hormones help regulate BMR

How is your thyroid involved?

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Thyroid Definitions

- Hypothyroid – When the thyroid gland does not produce enough thyroid hormone
- Hyperthyroid – When an overactive thyroid produces an excessive amount of thyroid hormone
- Normothyroid – Like Goldilocks and the third bed.

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Thyroid Gland Produces...

Follicular cells produce

- **T4, Thyroxine/thyroglobulin**
 - This prohormone might have some weak activity compared to T3. The cell nucleus responds nearly exclusively to T3 activity
- **T3, Triiodothyronine**
 - Virtually all T3 is converted from T4 inside the cell via a series of selenium-based enzymes

Parafollicular cells of the thyroid produce

- **Calcitonin** – Not part of the metabolic cascade – But let's quickly cover this part of thyroid function.

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Para-follicular cells - Calcitonin

Just one slide on Calcitonin

- Calcitonin promotes bone mineralization
- Complete hypothyroidism results in low serum calcitonin
- Thyroid prescriptions have no significant calcitonin
- Neighboring Parathyroid compensates PTH levels and surprisingly osteoporosis is not associated with hypothyroid

Osteoporosis IS associated with elevated thyroid hormones from hyper- or prescription thyroid

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Back to the Follicular Cells

In the thyroid cascade of communication Follicular cells produce

- **T4, Thyroxine/thyroglobulin**
- **T3, Triiodothyronine**

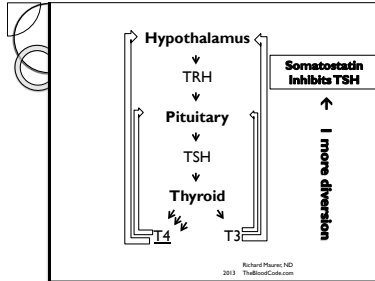
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Thyroid Cascade

Negative Feedback

- **Biological definition:** A system in which the system responds in an opposite direction to the perturbation.
 - T4 and T3 come from the thyroid gland
 - These hormones feedback to pituitary and hypothalamus gland
 - This reduces the TSH and TRH production
 - DIO enzymes may also be involved in cellular feedback of some type – more on this...

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Somato-what?

- Somatostatin (aka Growth Hormone Inhibiting Hormone, GHIH) is the compensatory hormone to somatotropin, (aka Growth Hormone, GH)
- Somatostatin secreted from the Hypothalamus goes to inhibit TSH and GH
- Somatostatin secreted from the pancreas inhibits insulin and glucagon and pancreas secretions
- Somatostatin is secreted from the digestive tract cells and suppresses digestive hormones, enzymes and mesenteric blood flow

Somatostatin respect

- The checks and balances of thyroid function are well beyond the over simplified:

TRH → TSH → T4 & T3 → T3/rT3

Thyroid Definitions

- Hypothyroid – When the thyroid gland does not produce enough thyroid hormone
- Hyperthyroid – When an overactive thyroid produces an excessive amount of thyroid hormone
- Normothyroid – Like Goldilocks and the third bed.

TSH → T4 & T3

Reference ranges for thyroid function

TSH: 0.3-3.5 mIU/mL
Free T4: 0.7-1.9 ng/dL
Free T3: 2.3-4.2 pg/mL

Other tests that claim value

- TRH stimulation test
- Free T3/rT3 ratio
- Basal Body Temperature

TRH Stimulation Test

- Hypothalamic TRH stimulates Pituitary TSH
- There is speculation that some might have a hyper responsive pituitary, so TSH elevation is inadequate for desired thyroid hormone secretion.
- Telltale /Practical sign–High norm TSH with Low T4
- TRH is unsubstantiated and unlikely to return as a screening test for hypothyroidism.

• Suhail AR, et al. TRH Stimulation When Basal TSH is Within the Normal Range: Is There "Sub-Biochemical" Hypothyroidism? Clin Med Res. 2007 Oct; 5(3): 145–148.

Free T3/rT3 Ratio

- Depending upon the reference range of your lab – the desirable number is different.
- Proponent claim that the higher the ratio, the better.
 - Presumes the more active T3, compared to inactive rT3.

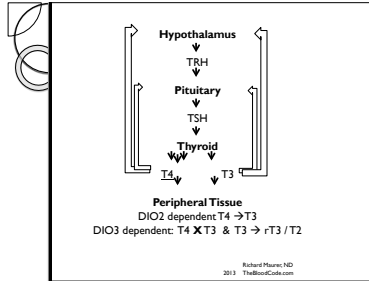
Basal Body Temperature

- Our basal body temperature is one expression of our cellular metabolism, and theories were established many years ago that oversimplified our complex thermodynamic regulation and hormonal and chemical cascade
- Hypothyroid became the scapegoat.

Basal Body Temperature

- “While thyroid hormones do influence metabolic function and temperature, they are, [perhaps the lesser] among many hormones and messenger molecules involved in this regulation, including sex hormones, leptin, epinephrine, norepinephrine, and cytokines.”
- Kelly Greg, Body Temperature Variability: Masking Influences of Body Temperature Variability and a Review of Body Temperature Variability in Disease. *Alt Med Rev.* Vol 12, No.1 2007.

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Doctrine of Viz Medicatrix Naturae

- The Healing Power of Nature is the inherent self-organizing and healing process of living systems which establishes, maintains and restores health.
- It is the goal of the physician and **each of us as individuals** to recognize and understand this ordered and intelligent healing process within ourselves. -RM

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Prevalence of hypothyroid using TSH

- Over 25,000 had their TSH tested
- 9.5% of those tested were above the reference range (0.3-5.1).
- 60% of those that were on thyroid prescriptive treatment still had TSH outside the reference range.
- Data: **The Colorado thyroid disease prevalence study.**

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Who develops hypothyroidism

- Women represent about 75% of those diagnosed with hypothyroidism.
 - Greater hormonal variation/stress throughout a woman's life
 - Greater incidence of auto-antibodies
- Men are rarely tested for hypothyroidism. Men represent less than 10% of people treated for hypothyroid, yet 25% who have it
- Gender difference are similar for hyperthyroid.

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TSH → T4 & T3

It is generally observed that thyroid hormone sensitivity, reflected by a low normal TSH is desirable.

TheBloodCode Reference ranges:

TSH: 0.3-3.5 mIU/mL
Free T4: 0.7-1.9 ng/dL
Free T3: 2.3-4.2 pg/mL

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TSH: Mild Elevation

- “mild/ subclinical/ low-grade”
 - These prefixes describe elevations of TSH “within normal limits”
- High TSH, above the ref. range, is termed “hypothyroid.”
- TSH, within normal range, still relates to symptoms & disease risk, “subclinical/mild/ slight hypothyroid” is conveniently, but erroneously used.
- WHY has TSH been implicated?

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TSH & Endothelial Inflammation

- Impaired endothelial function, suggesting early-stage atherosclerosis, may be more prevalent in female hypothyroid patients and in people with TSH levels in the upper part of the reference range (.3-3.7)
- Dagne AG, et al. Abnormal endothelial function in female patients with hypothyroidism and borderline thyroid function. *Int J Cardiol* 2007; 114 (3) 332- 338.

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TSH & CHD Severity

- Low but clinically normal thyroid function is associated with more severe coronary and carotid atherosclerosis and increased carotid artery intima media thickness
 - Measured by TSH in patients with cardiac-related chest pain
- Yun KH, et al. Relationship of thyroid stimulating hormone with coronary atherosclerosis in angina patients. *Int J Cardiol* 2007; 122 (1) 56- 60

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TSH & Blood Pressure/Lipids

- Linear and positive associations between thyrotropin (TSH) levels within the reference range and BP, and less favorable serum lipid profiles in people with higher thyrotropin levels have been reported
 - Asvold B, et al. Association between blood pressure and serum TSH concentration within the reference range. *J Clin Endocrinol Metab* 2007;92 (3) 841- 845.
 - Asvold B, et al. The association between TSH within the reference range and serum lipid concentrations. Hunt Study.

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TSH & CHD mortality in women

- This study shows that CHD mortality increases in women with increasing levels of thyrotropin (TSH) within the reference range (0.5-3.5).
 - [This study failed to separate the CVD risk related to the insulin resistance found commonly in those with elevated TSH. - RM]
- Asvold Bjorn, et al. Thyrotropin Levels and Risk of Fatal Coronary Heart Disease. *Arch Intern Med.* 2008;168(8): 855-860 "HUNT study"

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TSH & Weight - BMI

- It has been suggested that thyrotropin (TSH) levels within the reference range may be positively associated with body mass index
 - Knudsen N, et al. Small differences in thyroid function may be important for body mass index and the occurrence of obesity in the population. *J Clin Endocrinol Metab* 2005;90(7) 4019-4024.

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Let's Prescribe T4 to lower CHD?

Not so fast!

- Data has not correlated prevention of CHD to prescription T4 therapy, only a reduction in questionable risk factors like total cholesterol in women.
- FT₄-TSH feedback is not linear with T4 Rx for "subclinical hypothyroid".
- Active T3 levels did not improve despite T4 prescription.
- Peripheral activation and de-activation of T3 via the DIO activity adjusts to low TSH in untreated individuals and this compensation "deranges" with hormonal treatment.
- TSH is the only corollary to blood pressure and lipids, not T4.

• Hoermann R, et al. Is pituitary TSH an adequate measure of thyroid hormone-controlled homeostasis during thyroxine treatment? *Eur J Endocrinol* Feb. 1, 2013; 1(48):377-380.
• Roalson JR, et al. Initial thyroid status and cardiovascular risk factors: the EPIC-Norfolk prospective population study. *Clin Endocrinol* 2010 Mar;72(3):404-10.

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Maybe TSH doesn't indicate thyroid

- Then what IS being measured with higher TSH levels?
 - INSULIN RESISTANCE**
- Increased TSH levels are negatively associated with insulin sensitivity.
 - Fernández-Real et al. Thyroid function is intrinsically linked to insulin sensitivity and endothelium-dependent vasodilation in healthy euthyroid subjects. *J Clin Endocrinol Metab* 2006;91(9) 3337-3343.

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High TSH and Insulin Resistance

- The association is clear
- Evolutionary theory: Both conditions are similarly advantageous under similar environmental circumstances
- But which comes first?
 - Hypo-thyroid → IR
 - IR → hypo-thyroid

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Insulin Resistance → Higher TSH

- TSH levels were much higher in those with a MetS diagnosis
- IR was causally linked to the onset of enlarged thyroid and nodules in iodine deficient environments
 - Measured as thyroid growth and nodules
 - Measured as elevations in TSH

• Ayurk S. Metabolic syndrome and its components are associated with increased thyroid volume and nodule prevalence in a mild-to-moderate iodine-deficient area. *Eur J Endocrinol* 2009 Oct; 161(4):599-605.

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CHD with high TSH is due to IR

- After a decade of associating high TSH to high CHD risk...
- "CHD risk related to "hypothyroidism" and "sub-clinical hypothyroidism" is likely related to the present IR."

• Maratou E, et al. Studies of insulin resistance in patients with clinical and subclinical hypothyroidism. *Eur J Endocrinol.* 2009 May; 160(5):785-90.

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Subclinical hypothyroid & TSH

- Clinical trials to date have not consistently shown a beneficial effect of T4 treatment on serum lipids in "subclinical hypothyroid".
- "Insulin resistance may be a contributing reason for abnormal lipid values"
 - Pearce, EN. Update in lipid alterations in subclinical hypothyroidism. *J Clin Endocrinol Metab* 2012 Feb; 97(2):326-33.

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TSH – a case of mistaken identity

- TSH likely rises secondary to insulin resistance. But it is not all from the top down!
- Peripheral conversion of thyroid hormone is likely more important than the thyroid cascade.
- → Enter DIO 1, 2 & 3.

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DIO's & Peripheral Conversion

DIO = Iodothyronine Deiodinase

Peripheral Tissue
DIO2 dependent T4 → T3
DIO3 dependent: T4 X T3 & T3 → rT3 / T2

- T3 levels are 98% dependent upon these peripheral activators/deactivators

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What are the DIO enzymes?

- The iodothyronine deiodinases (DIO) are selenocysteine-containing enzymes:
 - DIO1 is the least active
 - DIO2 is the primary intracellular activator of T3
 - DIO3 can prevent activation and/or deactivate T3
- DIO3: the DIO3 enzyme irreversibly inactivates T3, or prevents T4 being activated, by removal of an inner ring iodine atom to generate T2 or rT3 respectively

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DIO Enzymes are now seen as 1°

- The discovery of these new roles and mechanisms for the deiodinases indicates that **tissue-specific deiodination** plays a much broader role than once thought, involving developmental biology and metabolism.
 - Bianco AC, et al. Deiodinases: implications of the local control of thyroid hormone action. *J Clin Invest* 2006 Oct;116(10):2571-9.
 - Agereben, B, et al. Activation and inactivation of thyroid hormone by deiodinases: local action with general consequences. *Cell Mol Life Sci* 2008 Feb;65(4):570-90.

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Does T3 measure your metabolism

- It remains unclear which T3-responsive energetic processes are most relevant for the determination of basal metabolic rate
- **Bile acids** can activate local production of thyroid hormone via induction of the type 2 deiodinase
 - Kim, B., Thyroid hormone as a determinant of energy expenditure and the basal metabolic rate. *Thyroid*. 2008. 18(2): p. 141-4.

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DIO enzymes and Bile Acids

- BAs increase post-prandially in the serum
- BA's signal the TGR5 receptor that secretes glp-1 and activate DIO2 in brown adipose tissue and muscle.
- Ruh-roh! Another drug for type 2 DM that raises insulin! "These properties position TGR5 as an attractive and "drugable" mechanism for those with MetS"
 - Thomas C, et al. Bile acids and the membrane bile acid receptor TGR5—connecting nutrition and metabolism. *Thyroid* 2008 Feb;18(2):167-74.

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Thyroid & Bile Acids & Insulin

In summary:

- After eating, when Bile acids release, there is an activation of T3, thereby raising tissue metabolic rates
 - the opposite of fasting/anorexia where T3 levels drop
- Bile acids stimulate the gut receptor that raises insulin.
 - Excess elevation of insulin is one of the first steps to insulin resistance?

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DIO3/DIO2 & Insulin Resistance

- Deiodinase enzymes regulate:
 - Tissue-specific regulation of thyroid hormone metabolism via local and central control.
 - Local adjustments to thyroid hormone action
 - Target gene transcription patterns
- **There is a subsequent regulation of glucose homeostasis and insulin sensitivity.**
 - Chidakei A, et al. *Peripheral metabolism of thyroid hormone and glucose homeostasis. Thyroid* 2005 Aug; 15(8):899-903.

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What Slows T3 Metabolism?

- Negative caloric balance
- Intensive Exercise
- Elevations in stress neurotransmitters & elevations in serum cortisol.
- Many meds, surgeries & chronic illness
- Diabetes and insulin resistance

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Why Slow T3 Metabolism?

- **Preservation Theory:** As you age, exercise, fight illness, restrict calories, and respond to daily stresses, your thyroid activity compensates to help "preserve your capital"
- **Adaptive theory:** As active metabolism is dominant during demanding exercise, T3 dependent BMR is minimally important.
- **Inflammatory theory:** DIO2 which activates T3 enhances cellular activity and thereby increases the cellular inflammatory response.

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Preservation: TSH & Longevity

- Results simply indicate that those with the higher TSH and Lower Free T4 and Free T3 levels were more likely to live the longest.
 - *Rozing, M.P., et al., Familial Longevity Is Associated with Decreased Thyroid Function. J Clin Endocrinol Metab, 2010.*
 - *Rozing, M.P., et al., Low serum free triiodothyronine levels mark familial longevity: the Leiden Longevity Study. J Gerontol A Biol Sci Med Sci, 2010. 65(4): 365-8.*

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Preservation: TSH & Longevity

- Elderly individuals with abnormally high levels of thyrotropin (TSH) do not experience adverse effects and may have a prolonged life span
- In people **over age 65**, subclinical hypothyroidism is not associated with impairment of physical and cognitive function or depression.
 - *Gussekloo, et al. Thyroid status, disability and cognitive function, and survival in old age. JAMA 2004;292 (21) 2591- 2599.*
 - *Gessing A, et al. The thyroid gland and the process of aging: what is new? Thyroid Research 2012, 5:16.*

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Thyroid & Aging/Longevity

Who were the exceptions?

- Those with higher TSH levels (>8 mIU/l)
- Those with positive thyroid peroxidase antibodies
 - Therefore proper thyroid treatment should be initiated sooner if either finding is present.

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Preservation: T3 & Cal. Restriction

- Men & Women: 1800, 2400, 2800 kcal diet
- Calorically restrictive (CR) diets are assoc w longevity in mammals.
- 1800 kcal group had lower serum T3 levels
- TSH, TT4, FT4, and rT3 were the same
- Researchers conclude a possible reason: "dec. in T3 may increase lifespan by conserving en & dec. free-radical formation"
- *Fontana, L et al. Effect of long-term calorie restriction with adequate protein and micronutrients on thyroid hormones. J Clin Endocrinol Metab. 2006 Aug;91(8):3232-3.*

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Exercise! Your Active Metabolism

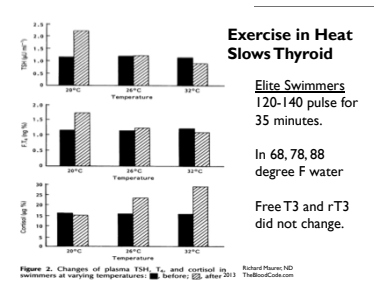
- Adaptive theory – as active metabolism is dominant during demanding exercise, T3 dependent resting metabolism can take a back seat.
- Your active metabolism is the cellular effect from dozens of hormones

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Adaptive Theory: All Exercise

- Initially, almost all hormones increase with the onset of better circulation.
- TSH, T4, FT4, FT3, Total T3 all increase.
- After 5', as intensity increases, the TSH and T4 continue to stay elevated, but the T3 hormones decrease back to baseline
- T3 drops the longer and more intense the exercise (>20-30 minutes).
 - *Ciloglu, F et al. Exercise intensity and its effects on thyroid hormones. Neuroendocrinology Letters No.6 December Vol.26, 2005*

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Adaptive Theory: Aerobic ex.

- **Basal Metabolic Rate unchanged after aerobic exercise x 12 weeks.**
- Benefits: Free fatty acids were elevated in the exercise group, from the muscles utilization of fats for energy.
- The VO2Max for the exercisers improved. They were in better shape!
- **Circulating Free-Thyroxine (FT4) levels decreased in the exercise group!**
 - *Lee MG, et al. Resting metabolic rate after endurance exercise training. Med Sci Sports Exerc. 2009 Jul; 41(7):1444-51.*

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Adaptive Theory: Conditioning

- Athletes ran 75 km and 45 km
- Pre & post workout T4, T3, TSH & rT3
- Younger and better-conditioned runners had stable T4, TSH, T3 levels.
- Older and less-conditioned athletes reacted to the stressful exer with decreased T4, T3 & TSH.
- The response was seen as exhaustion reaction
 - Hesse V, et al Thyroid hormone metabolism under extreme body exercises. *Exp Clin Endocrinol.* 1989 Sep;94(1-2):82-8.

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Adaptive Theory: Stressful exer.

- Intensive exercise (IE) was 90" of 110% of VO2 max w/ 90" at 40% VO2max for 45!
- Steady endurance exercise (SEE) was 45 min at 60-65% of VO2max.
- Free T4, Free T3, Reverse T3 and cortisol
 - All hormones were up immediately post-exertion
 - 12 hours after: only IE group had a persistent elevation of Reverse T3 and diminished Free T3.
 - Hackney AC, et al Thyroid hormonal responses to intensive interval versus steady-state endurance exercise sessions. *Hormones (Athens).* 2012 Jan-Mar;11(1):54-60.

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Stress – A Model of Adaptation

When extreme stress is placed upon the body...

1. Increase in plasma cortisol & catecholamine
2. Over time, physical results in a reduction of pituitary-adrenal activation in response to exercise & stress.
3. Although, highly trained athletes exhibit chronic mild hypercortisolism at baseline, AND...
4. the proinflammatory cytokine, IL-6 is also activated.

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Stress – A Model of Adaptation

5. Peripheral thyroid hormone metabolism changes, suppression of T3 and elevation of rT3
6. Activation and nuclear translocation of NF-kappaB leads to incr transcription of proinflammatory genes
7. Which in turn inhibits NF-kappaB activation through IkappaB and genetically shuts down this inflammatory cycle.

*◦ Mastorakos G. Exercise as a stress model and the interplay between the hypothalamus-pituitary-adrenal and the hypothalamus-pituitary-thyroid axes. *Horm Metab Res.* 2005 Sep; 37(9):577-84.*

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The Thyroid Scapegoat

Terms like "Sick", "Bad", "Hypo-" & "Depressed"; all present an unfortunate fall-guy.

The findings/symptoms that lead a clinician or researcher to one of these terms can inappropriately label the thyroid gland with a disease that is, in fact, your brilliant adaptation to non-thyroid influences on your body.

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Tests That Signal Thyroid Problems

- TSH >6.0 mIU/mL.
- If TPO Antibodies are elevated [Ref range <10]
 - The higher, the greater the lifetime likelihood of a thyroid problem
- Past age 65, some hypothyroid findings on blood tests might be tolerable,
 - May allow TSH up to 5-6 mIU/L and Free T3 below 2.0 pg/mL.
- **If borderline high TSH, evaluate for Insulin Resistance!**

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Insulin Resistance: TheBloodCode

1. Complete Blood Count
2. Comprehensive Metabolic Panel
3. HgbA1C
4. Serum Insulin
5. Lipid Panel
6. Optional Vitamin D, Ferritin, CRP

Assess TG:HDL Ratio & HOMA-IR for presence & extent of insulin resistance

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"I have been and still am a seeker, but I have ceased to question stars and books; I have begun to listen to the teaching my blood whispers to me."

Hermann Hesse, from Demian
The Blood Code – Step One

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Dietary changes to implement

- Reduce CHO intake to your set-tolerance and replace with dietary fats and vegetables. Your CHO tolerance can be found at BloodCode.com
- Reduce simple sugar and fructose
- Assure micronutrient intake and adequate protein as building blocks for thyroid hormones and activators
- Address underlying insulin resistance. The other side of the diet coin is fitness...

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Implement Fitness – Daily!

Improve overall conditioning so stress is better tolerated. **Not just stress from exercise, but from EVERYTHING.**

If you need convincing, read

- “Younger Next Year,” Cowley and Lodge
- “Stress-Defeating Effects of Exercise Traced to Emotional Part of the Brain”
 - Lehmann, M.J., and Herkenham, M. Environmental enrichment confers stress resiliency to social defeat through an infralimbic cortex-dependent neuroanatomical pathway. *Journal of Neuroscience* 31:6159-6173, 2011

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Nutrient Needs for Thyroid balance

Nutrient Supplementation is to prevent deficiency, beware the claim that something “stimulates” or “activates” your thyroid.

- Iodine:
 - **USRDA= 120 mcg - Up to 290 mcg for lactation!**
 - **Reasonable Adult Supplemental Range = 50-300 mcg**
- Selenium:
 - **USRDA= 50-70 mcg**
 - **Reasonable Adult Supplemental Range = 50-200 mcg**
- Zinc
 - **USRDA= about 10 mg - Up to 13 mg for lactation**
 - **Reasonable Adult Supplemental Range = 5-25 mg**
- Vanadium – this is easy through any diet.
 - **USRDA= not established (diet contains 10-30 mcg)**
 - **Adult Supplemental Range = 20 mcg-100 mcg**

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Iodine and TSH/DIO2 Too much?

- Iodine was given (rats) at normal, 3-fold, 6-fold, 10-fold, 50-fold quantities.
- Measurement of TSH levels and DIO2 levels and gene expressions in Blood and pituitary
- From 8 weeks onward in the study the 10-fold and 50-fold iodine uptake inhibits pituitary D2 activity and induces elevation of TSH levels.
 - Lin N. et al. Prolonged high iodine intake is associated with inhibition of type 2 deiodinase activity in pituitary and elevation of serum thyrotropin levels. *Br J Nutr* 2012 Mar;107(5):674-82.

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Food Sources of Iodine **mcg**

• Seaweed, whole or sheet, per 5 gram	10 - 2,400
• Cod, baked, 3 ounces	99
• Yogurt, plain, whole, 1 cup	75
• Iodized salt, fine, 1.5 g (1/4 tsp)	71
• Milk, 1 cup	56
• Shrimp, 3 ounces	35
• Sardines, 1 can	35
• Egg, 1 large	24

• There is no substantial iodine in red meats

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Food Sources of Selenium

Food	Micrograms
• Brazil nuts (6-8 nuts)	544
• Tuna, light, canned, 3 ounces	68
• Cod, cooked, 3 ounces	32
• Turkey, light meat, 3 oz	27
• Bagel, egg, 4 inch	27
• Chicken breast, meat only, 3 oz	24
• Beef chuck roast, 3 ounces	23
• Sunflower seed kernels, dry, 1 oz	23
• Ground beef, cooked, broiled, 3 oz	18
• Egg, whole, hard-boiled, 1 large	15

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Food Sources of Zinc

- Oysters, which are the best source of zinc. **15-200 mg per 3 ounces.**
- Red meat, poultry, seafood such as crab and lobsters, All are about 10-20 mg per 3 ounces.
- Beans, nuts, whole grains, contain about 3-8 mg per cup
- Dairy products provide minimal amounts

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Food Sources of Vanadium

- #1 – Radishes – 80mcg per 3 ounces
- Shellfish & Fish
- Parsley, dill, black pepper
- Mushrooms
- Olives

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Thyroid – Metabolism - Health

“The doctor has been taught to be interested not in health but in disease. What the public must be taught is that health is the cure for disease.”

Prevention is not the domain of the doctor.
Your vibrant and long life comes from regularly practicing & exercising your health.

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