Functional Medicine Training Program

Module 7 * FDMT 563D

Functional Medicine Approach to Diagnosis and Treatment of Thyroid Dysfunction

Wayne L. Sodano, D.C., D.A.B.C.I.
&
Ron Grisanti, D.C., D.A.B.C.O., M.S.

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Case History

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Case Study : 02/08/2006

Patient: Female 48 years-old

Occupation: School bus driver

Previous Occupation: Worked with/around motor vehicles; family business. Pumped own fuel daily.

Chief complaint: " *All joints hurt" (Patient questions possibility of MS? RA? Autoimmune Disease?)*

- Started Synthroid .05 mg: 2/7/2006
- Cancerous colon polyp removed 7/23/2004
- Herpes simplex (chronic breakouts)
- Carpal Tunnel Syndrome
- Positive TPO (Thyroid Antibody)

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Review of Systems & Past History

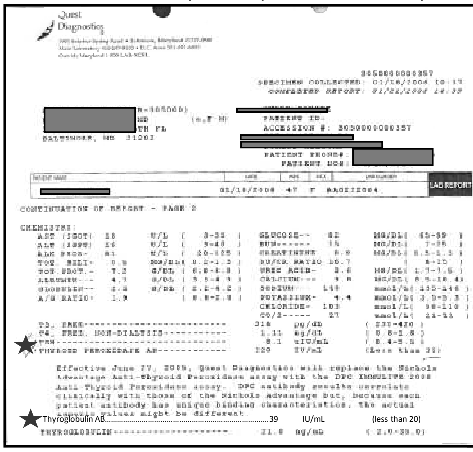
- Enlarged thyroid
- Bruising easily and dry skin
- Weight gain, weakness, sleeping disturbances, hot flashes, low sex drive, low blood pressure, MVP, depression/mood swings
- Endometriosis/uterine fibroids
- Hysterectomy 12/26/2000; left ovary, adhesions and appendix 12/7/2001

Menstrual History

- Age 14: Menarche; irregular cycles 26-48 days
- Age 17: Began BCP; regular periods for 8 years; no health problems
- 1984: First yeast infection
- 1984: Married; stopped BCP – irregular periods began with heavy bleeding and clotting
- Age 33: Bleeding on/off during first pregnancy-delivered 2 weeks early-breast fed 3 months-stopped due to bleeding nipples
- Age 36: 2nd pregnancy no bleeding – breast fed 19 months – no problems
- Ages 38-39: Menstrual cycles better
- Age 40: Began with heavy bleeding/clotting
- Age 43: Fibrocystic breast disease
- Age 46: Began treatment with medical doctor.

Physical Exam

- Ht: 5’ 4”
- Wt: 140 lbs
- Pulse: 68 b/m
- Resp: 16
- Temp: 98.2
- BP: 110/64 R 116/70 L
- Neuro/Ortho: WNL
- Abd: left lower quadrant: significant tenderness
- Hair: Thin: pulls out easily
- Skin: Dry scalp
- Tongue: White coating, scalloped



Blood tests ordered by primary care physician prior to initial visit

Health Symptom Assessment Questionnaire

Name: [redacted] Date 2 / 11 / 06 Test #:

Organ/System	Total	%T
Digestion Problems	9 /21	43
Liver/Gall Bladder	17 /48	35
Large Intestine	13 /18	72
Allergies	8 /21	38
Immune System	3 /15	20
Blood Sugar Problems	40 /65	61
Vitamin B Deficiency	50 /72	69
Vitamin C Deficiency	34 /78	44
Fatty Acids Deficiency	16 /60	27
High Autonomic	21 /42	50
Low Autonomic	23 /39	59
High Pituitary	7 /18	39
Low Pituitary	9 /21	43
High Thyroid	15 /27	56
Low Thyroid	23 /30	77
High Adrenal	5 /15	33
Low Adrenal	19 /48	40
Nutritional Deficiency	20 /78	26
Heart Function	11 /18	61
Female Hormonal	9 /36	25
Male Hormonal	— /30	

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[redacted]
Dr. Wayne L. Sodano
[redacted]
Bel Air, Maryland 21015

NAME: [redacted]
GENDER: Female
BIRTH DATE: 8/20/1958
[redacted]
DATE GENERATED: 3/1/2006

Dear Mrs. [redacted]

The results of your physical examination and blood tests reveal the following diagnoses:

1. Hashimoto's thyroiditis (hypothyroidism) (autoimmune disease)
2. Hypercholesterolemia (high cholesterol)
3. Anemia (pernicious) B12, folic acid deficiency
4. Estrogen and progesterone deficiency
5. Suspected inflammatory bowel disease (based upon a history of cancerous intestinal polyp and irregular bowel function)

Hashimoto's thyroiditis is the most common autoimmune disease affecting the thyroid and is characterized by elevated levels of antibodies to thyroid peridoxase (TPO) and thyroglobulin. These antibodies cause inflammation of the thyroid gland, which can result in a goiter and lead to diminished production of thyroid hormone. Hashimoto's is much more common in women, has a genetic predisposition and is often associated with other autoimmune disorders.

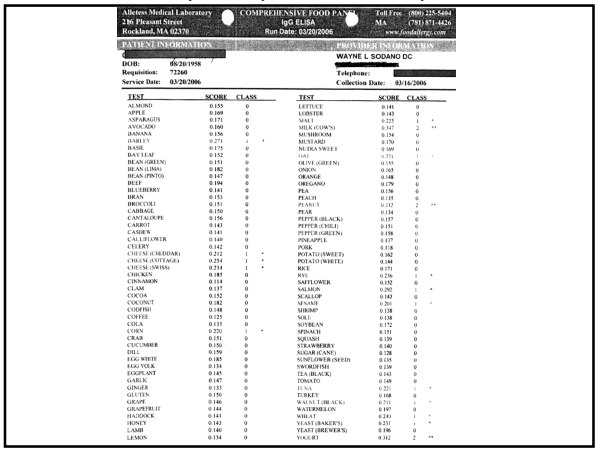
I believe the synthroid should be of some help in the short term. I believe it is the autoimmune disease that is responsible for your joint pain. There are several areas that require treatment. We need to begin with normalizing your immune system and restoing hormoe balance. The following are my initial treatment recommendations.

1. Food sensitivity test
2. [redacted] (helps detoxify and reduce inflammation in the body)
3. [redacted](natural anti-inflammatory) 1 tablet three times a day
4. [redacted](essential fatty acids- aids the body by decreasing inflammation) 2 capsule three times a day
5. [redacted] (probiotic for restoring health bacteria in the intestine- also acts as an anti-inflammatory agent) 2 capsule three times per day
6. [redacted] (natural estrogen and progesterone replacement)
7. 64 ounces of water per day
8. Daily exercise- walk one mile per day

FOLLOW-UP IN 4 WEEKS

Thank you for allowing me to assist with your health care.

Dr. Wayne L. Sodano



Alletess Medical Laboratory
2 Bt Pleasant Street
Rockland, MA 02370

COMPREHENSIVE FOOD PANEL
IgG ELISA
Run Date: 03/20/2006

Toll Free: (800) 225-5404
MA: (781) 871-4426
www.foodallergy.com

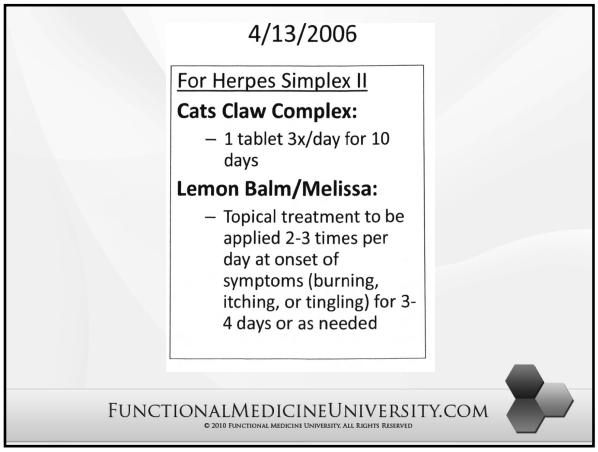
PATIENT INFORMATION

DOB: 06/20/1958
Requisition: 72260
Service Date: 03/20/2006

PROVIDER INFORMATION

WAYNE L SODANO DC
Telephone:
Collection Date: 03/16/2006

TEST	SCORE	CLASS		TEST	SCORE	CLASS	
ALMOND	0.155	0		LETTUCE	0.141	0	
APPLE	0.169	0		LOBSTER	0.143	0	
ASPARAGUS	0.171	0		MALT	0.225	1	*
AVOCADO	0.160	0		MILK (COW'S)	0.347	2	**
BANANA	0.156	0		MUSHROOM	0.154	0	
BARLEY	0.271	1	*	MUSTARD	0.170	0	
BASIL	0.175	0		NUTRA SWEET	0.169	0	
BAY LEAF	0.152	0		OAT	0.271	1	*
BEAN (GREEN)	0.151	0		OLIVE (GREEN)	0.155	0	
BEAN (LIMA)	0.182	0		ONION	0.165	0	
BEAN (PINTO)	0.167	0		ORANGE	0.148	0	
BEEF	0.194	0		OREGANO	0.179	0	
BLUEBERRY	0.141	0		PEA	0.156	0	
BRAN	0.153	0		PEACH	0.155	0	
BROCCOLI	0.151	0		PEANUT	0.332	2	**
CABBAGE	0.150	0		PEAR	0.134	0	
CANTALOUPE	0.156	0		PEPPER (BLACK)	0.157	0	
CARROT	0.143	0		PEPPER (CHILI)	0.151	0	
CASHEW	0.141	0		PEPPER (GREEN)	0.158	0	
CAULIFLOWER	0.149	0		PINEAPPLE	0.157	0	
CELERY	0.142	0		PORK	0.318	0	
CHEESE (CHEDDAR)	0.212	1	*	POTATO (SWEET)	0.162	0	
CHEESE (COTTAGE)	0.234	1	*	POTATO (WHITE)	0.164	0	
CHEESE (SWISS)	0.234	1	*	RICE	0.171	0	
CHICKEN	0.185	0		RYE	0.236	1	*
CINNAMON	0.114	0		SAFFLOWER	0.152	0	
CLAM	0.137	0		SALMON	0.292	1	*
COCOA	0.152	0		SCALLOP	0.143	0	
COCONUT	0.182	0		SESAME	0.201	1	*
CODFISH	0.148	0		SHRIMP	0.138	0	
COFFEE	0.125	0		SOLE	0.138	0	
COLA	0.133	0		SOYBEAN	0.172	0	
CORN	0.220	1	*	SPINACH	0.151	0	
CRAB	0.151	0		SQUASH	0.159	0	
CUCUMBER	0.150	0		STRAWBERRY	0.140	0	
DILL	0.159	0		SUGAR (CANE)	0.128	0	
EGG WHITE	0.185	0		SUNFLOWER (SEED)	0.155	0	
EGG YOLK	0.154	0		SWORDFISH	0.139	0	
EGGPLANT	0.145	0		TEA (BLACK)	0.143	0	
GARLIC	0.147	0		TOMATO	0.149	0	
GINGER	0.133	0		TUNA	0.221	1	*
GLUTEN	0.150	0		TURKEY	0.168	0	
GRAPE	0.146	0		WALNUT (BLACK)	0.711	1	*
GRAPEFRUIT	0.144	0		WATERMELON	0.197	0	
HADDOCK	0.141	0		WHEAT	0.243	1	*
HONEY	0.143	0		YEAST (BAKER'S)	0.231	1	*
LAMB	0.140	0		YEAST (BREWER'S)	0.396	0	
LEMON	0.134	0		YOGURT	0.312	2	**



4/13/2006

For Herpes Simplex II

Cats Claw Complex:

- 1 tablet 3x/day for 10 days

Lemon Balm/Melissa:

- Topical treatment to be applied 2-3 times per day at onset of symptoms (burning, itching, or tingling) for 3-4 days or as needed

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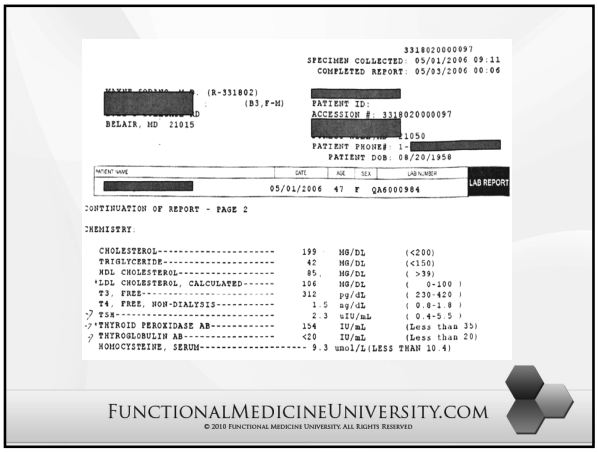

3318020000097
SPECIMEN COLLECTED: 05/01/2006 09:11
COMPLETED REPORT: 05/03/2006 00:06

(R-331802)
(B3,F-M)
BELAIR, MD 21015

PATIENT ID:
ACCESSION #: 3318020000097
1050
PATIENT PHONE#: 1-
PATIENT DOB: 08/20/1958

PATIENT NAME	DATE	AGE	SEX	LAB NUMBER	
	05/01/2006	47	F	QA6000984	LAB REPORT

CONTINUATION OF REPORT - PAGE 2

CHEMISTRY

CHOLESTEROL	199	MG/DL	(<200)
TRIGLYCERIDE	42	MG/DL	(<150)
HDL CHOLESTEROL	85	MG/DL	(>39)
*LDL CHOLESTEROL, CALCULATED	106	MG/DL	(0-100)
T3, FREE	312	pg/dL	(230-420)
T4, FREE, NON-DIALYSIS	1.5	ng/dL	(0.8-1.8)
-? TSH	2.3	uIU/mL	(0.4-5.5)
-? *THYROID PEROXIDASE AB	154	IU/mL	(Less than 35)
-? THYROGLOBULIN AB	<20	IU/mL	(Less than 20)
HOMOCYSTEINE, SERUM	9.3	umol/L	(LESS THAN 10.4)

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Recommended protocols
5/4/2006

Daily:

[redacted]: Thyroid Sup #1
– 2 tablets 3x/day with meals

[redacted]: Thyroid Sup #2
– 1 tablet 3x/day with meals

[redacted] C
– 4 tablets per day (chewable)

– Follow up 4-6 weeks

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[redacted] (R-331802)
(83,F-M)

SPECIMEN COLLECTED: 06/27/2006 09:53
COMPLETED REPORT: 06/29/2006 04:11

[redacted]
PATIENT ID:
ACCESSION #: 3318020000133
[redacted]
PATIENT PHONE#: 1-[redacted]
PATIENT DOB: 08/20/1958

PATIENT NAME	DATE	AGE	SEX	LAB NUMBER	
[redacted]	06/27/2006	47	F	QA6773057	LAB REPORT

CONTINUATION OF REPORT - PAGE 2

*** REFERENCE VALUES ***

Non-Pregnant Female:
Follicular Phase 0.2-1.4 ng/mL
Luteal Phase 3.3-24 ng/mL
Mid-Luteal Phase 4.4-28 ng/mL
Post Menopausal 0-0.7 ng/mL
Oral Contraceptives 0.1-0.3 ng/mL
Pregnant Female:
First Trimester 11-45 ng/mL
Second Trimester 26-89 ng/mL
Third Trimester 48-423 ng/mL

*SEX HORMONE BINDING GLOBULIN-----	111	nmol/L	(8-96)
*T3, FREE-----------------------	858	pg/dL	(230-420)
*T4, FREE, NON-DIALYSIS----------	2.0	ng/dL	(0.8-1.8)
*TSH----------------------------	0.03	uIU/mL	(0.4-5.5)
ESTRADIOL-----------------------	36	pg/mL	

Reference Range for Estradiol:
Female:
Follicular Phase: 11 - 212 pg/mL
Mid-Cycle: 18 - 480 pg/mL
Luteal Phase: Less than or equal to 247 pg/mL
Post-Menopausal: Less than or equal to 27 pg/mL

Male: 13 - 54 pg/mL

No pediatric reference range established. For patients less than 18 years of age, the Nichols Estradiol assay (extraction/chromatography/RIA Method) is recommended (Order Code 30289N).

*THYROID PEROXIDASE AB----------	112	IU/mL	(Less than 35)
THYROGLOBULIN AB----------------	<20	IU/mL	(Less than 20)

<<END OF REPORT - [redacted]057 - TOTAL 2 PAGE(S)>>

Recommended Treatment (7-3-2006)

1. Begin supplement to increase estrogen metabolism
2. Continue with multivitamin, vitamin C, EFA's, probiotics
3. Calcium supplement
4. Discontinue thyroid supplements (supplement 1 and 2) She also made the decision to stop taking the synthroid.
5. Decrease natural progesterone and estrogen supplementation
6. Follow up in six to eight weeks

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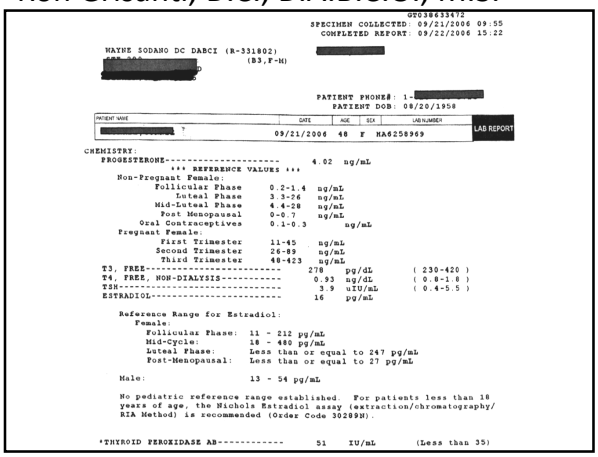


GD03963472
SPECIMEN COLLECTED: 09/21/2006 09:55
COMPLETED REPORT: 09/22/2006 15:22

WAYNE SODANO DC DABCI (R-331802)
(B3,F-M)

PATIENT PHONE#: 1-
PATIENT DOB: 08/20/1958

PATIENT NAME	DATE	AGE	SEX	LAB NUMBER	
?	09/21/2006	48	F	HA6258969	LAB REPORT

CHEMISTRY:

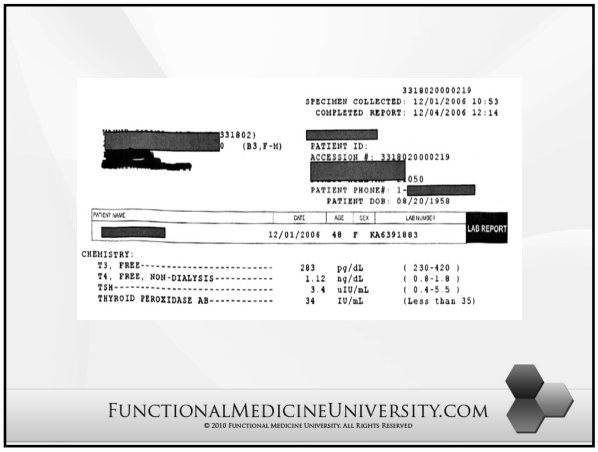
PROGESTERONE	4.02	ng/mL	
*** REFERENCE VALUES ***			
Non-Pregnant Female:			
Follicular Phase	0.2-1.4	ng/mL	
Luteal Phase	3.3-26	ng/mL	
Mid-Luteal Phase	4.4-28	ng/mL	
Post Menopausal	0-0.7	ng/mL	
Oral Contraceptives	0.1-0.3	ng/mL	
Pregnant Female:			
First Trimester	11-45	ng/mL	
Second Trimester	26-89	ng/mL	
Third Trimester	48-423	ng/mL	
T3, FREE	278	pg/dL	(230-420)
T4, FREE, NON-DIALYSIS	0.93	ng/dL	(0.8-1.8)
TSH	3.9	uIU/mL	(0.4-5.5)
ESTRADIOL	16	pg/mL	

Reference Range for Estradiol:
Female:
Follicular Phase: 11 - 212 pg/mL
Mid-Cycle: 18 - 480 pg/mL
Luteal Phase: Less than or equal to 247 pg/mL
Post-Menopausal: Less than or equal to 27 pg/mL

Male: 13 - 54 pg/mL

No pediatric reference range established. For patients less than 18 years of age, the Nichols Estradiol assay (extraction/chromatography/RIA Method) is recommended (Order Code 302898).

*THYROID PEROXIDASE AB	51	IU/mL	(Less than 35)



3318020000219
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COMPLETED REPORT: 12/04/2006 12:14

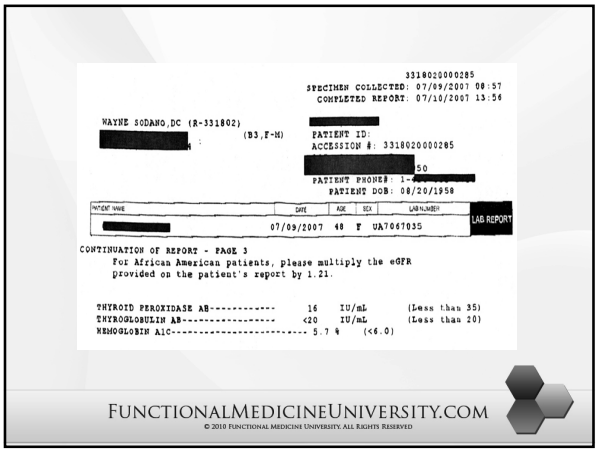
331802)
0 (B3,F-M)

PATIENT ID:
ACCESSION #: 3318020000219
050
PATIENT PHONE#: 1-
PATIENT DOB: 08/20/1958

PATIENT NAME	DATE	AGE	SEX	LAB NUMBER	
	12/01/2006	48	F	KA6391883	LAB REPORT

CHEMISTRY:

T3, FREE	283	pg/dL	(230-420)
T4, FREE, NON-DIALYSIS	1.12	ng/dL	(0.8-1.8)
TSH	3.4	uIU/mL	(0.4-5.5)
THYROID PEROXIDASE AB	34	IU/mL	(Less than 35)



3318020000285
SPECIMEN COLLECTED: 07/09/2007 08:57
COMPLETED REPORT: 07/10/2007 13:56

WAYNE SODANO,DC (R-331802)
(B3,F-M)

PATIENT ID:
ACCESSION #: 3318020000285
50
PATIENT PHONE#: 1-
PATIENT DOB: 08/20/1958

PATIENT NAME	DATE	AGE	SEX	LAB NUMBER	
	07/09/2007	48	F	UA7067035	LAB REPORT

CONTINUATION OF REPORT - PAGE 3
For African American patients, please multiply the eGFR provided on the patient's report by 1.21.

THYROID PEROXIDASE AB	16	IU/mL	(Less than 35)
THYROGLOBULIN AB	<20	IU/mL	(Less than 20)
HEMOGLOBIN A1C	5.7 %		(<6.0)

	1-18-2006	5-1-2006	6-27-2006	9-21-2006	12-1-2006	7-9-2007
TSH	8.1	2.3	0.03	3.9	3.4	
Thyroglobulin AB	39	<20	<20			
TPO AB	**220**	**154**	**112**	**51**	**34**	**16**
Free T3	318		858	273	283	
Free T4	1.11		2.0	.93	1.12	

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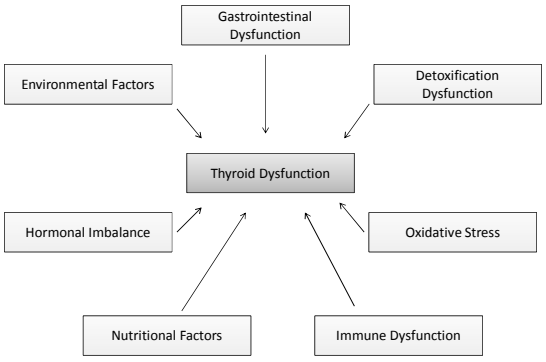
Functional Medicine University's Approach to assess the cause of thyroid dysfunction



Convergence of Diseases

Many experienced functional medicine practitioners often seen an overlapping signs and symptoms of metabolic, endocrine and immunological disorders as they relate to chronic disease.

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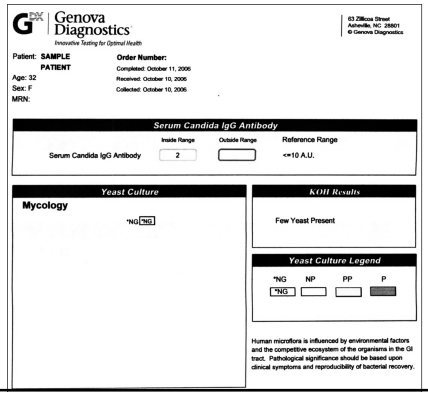
Chronic Mucocutanteous Candidiasis

Chronic mucocutanoeous candidiasis is frequently associated with endocrinopathies, such as:

- Hypoparathyroidism
- Addison disease
- Hypothyroidism
- Diabetes mellitus
- Autoimmune antibodies to adrenal, thyroid and gastric tissues
- Polyglandular autoimmune disease

Diagnostic Testing for Candida



Genova Diagnostics
Innovative Testing for Optimal Health

63 Zillicoa Street
Asheville, NC 28801
© Genova Diagnostics

Patient: SAMPLE PATIENT
Age: 32
Sex: F
MRN:

Order Number:
Completed: October 11, 2006
Received: October 10, 2006
Collected: October 10, 2006

Serum Candida IgG Antibody

	Inside Range	Outside Range	Reference Range
Serum Candida IgG Antibody	2		<=10 A.U.

Yeast Culture

Mycology

*NG

KOH Results

Few Yeast Present

Yeast Culture Legend

*NG	NP	PP	P
*NG			

Human microflora is influenced by environmental factors and the competitive ecosystem of the organisms in the GI tract. Pathological significance should be based upon clinical symptoms and reproducibility of bacterial recovery.

Treatment for Yeast/Fungi

- Reduce intake of refined carbohydrates, sugars and fermented foods
- Stool analysis for identification and sensitivity (botanicals and pharmaceuticals)
- Probiotics (esp. S. boulardii) – crowds out yeast
- Avoid fructooligosaccharides (FOS) - feeds yeast
- Optimize GI function- (check for H. pylori) treat hypochlorhydia and pancreatic enzyme insufficiency if present.

Celiac Disease

- Celiac disease is an immune-mediated disorder clinically characterized by a multitude of symptoms and complications. The comorbidity between celiac disease and other autoimmune disorders has been clearly established.
- Thyroiditis has been repeatedly associated with celiac disease.
- The participation of (T-helper cells-17) Th17 cells in the pathogenesis of the disease, a key cell population in other autoimmune diseases, appears to be a link between the celiac disease and autoimmune thyroid disease.

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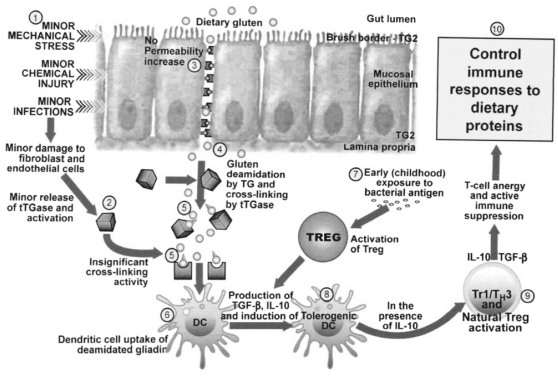
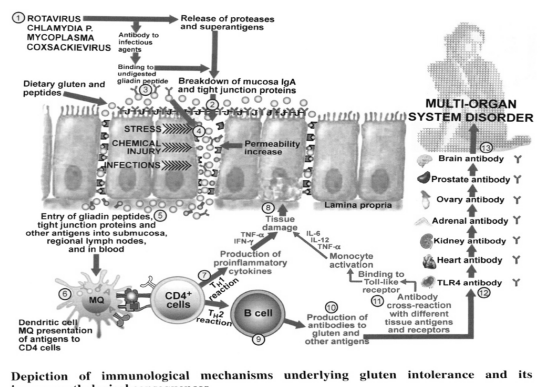


Cellular and molecular induction of immune tolerance to dietary proteins (gliadin).

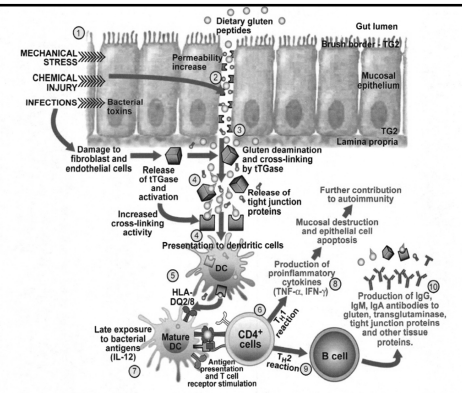


Depiction of immunological mechanisms underlying gluten intolerance and its immunopathological consequences.

Table 3– Diseases associated with low secretory IgA

Conditions	Disease
•Allergy	•Asthma, atopy, eczema
•Autoimmunity	•Rheumatoid arthritis ITP, hemolytic anemia, pernicious anemia, systemic lupus erythematosus, Still's disease, transfusion reactions due to anti-IgA antibody, dermatomyositis, vitiligo, Sjogren's syndrome, Henoch-Schonlein syndrome, primary biliary cirrhosis, autoimmune hepatitis
•Respiratory tract	•Recurrent sinopulmonary infections, sarcoidosis, pulmonary hemosiderosis
•Gastrointestinal diseases	•Giardasis, Crohn's disease, ulcerative colitis, nodular lymphoid hyperplasia, celiac disease, lactose intolerance, malabsorption villous atrophy, achlorhydria, cholelithiasis
•Neurological	•Seizures, migraine, sensory neuropathy, myasthenia gravis, cerebral vasculitis
•Familial history of hypogammaglobulinemia	•Common variable immunodeficiency
•Endocrinopathy	•Thyroiditis. Graves disease, idiopathic Addison's disease, diabetes mellitus, 21-hydroxylase deficiency
•Chromosomal abnormalities	•Chromosome 14
•Malignancy	•Gastric carcinoma and lymphoma

Reference: Assessment of Intestinal Barrier Permeability to Large Antigenic Molecules, Aristo Vojdani, Ph.D., M.T.



Depiction of the intestinal mucosa with emphasis on the factors involved in the development of celiac disease in individuals with HLA DQ2/DQ8-positive.

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The Major Subsets of CD4+ T Cells (Newly Discovered Th-17)

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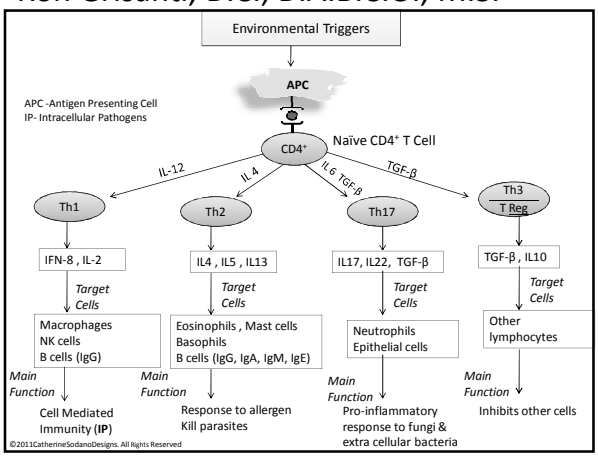

The Role of Th17 Cells in Autoimmunity

- The role of Th17 lymphocytes in immunopathogenic processes has recently been established.
- The results of a recent study on the role of Th17 cells indicates that there is an increased differentiation of Th17 lymphocytes and enhanced synthesis of Th17 cytokines in autoimmune thyroid disease, in particular Hashimoto's thyroiditis.
- It appears that the preferential production of IL-17 by the Th17 cells occurs during infections of specific pathogens such as, Klebsiella pneumonia, Bacteriodes fragilis,, Borrelia burgdoferi (Lyme disease), mycobacterium tuberculosis and fungal species

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Treatment for Opportunistic Bacterial Infection

- Stool analysis –to identify the cause of dysbiosis and provide a culture and sensitivity of pathogens for specific treatment agents
- Probiotics (avoid FOS if you are treating a yeast infection)
- Identify and treat for food sensitivity
- If sIgA is low, evaluate for the reason and treat accordingly

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Viral Infections and Thyroid Autoimmune Disease

- Viral infections activate both innate and adaptive immunity and have been implicated as a trigger of autoimmune diseases including Hashimoto's thyroiditis.
- To date, no environmental reports have clearly correlated viral infections with Hashimoto's thyroiditis.
- However, direct evidence of the presence of viruses or their components in the organ are available for retroviruses (HFV-Human papillomavirus) and mumps in subacute thyroiditis, for retroviruses (HTLV-1, HFV, HIV ans SV40) in Graves's disease and for HTVL-1, enterovirus, rubella, mumps, HSV, EBV and parvovirus in Hashimoto's thyroiditis.

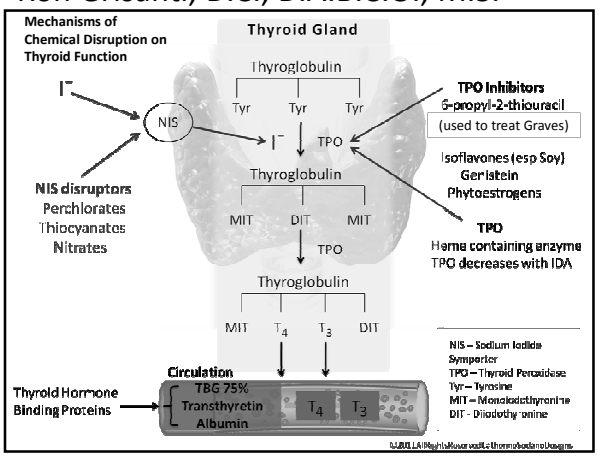
Effects of the Environmental on Thyroid Function

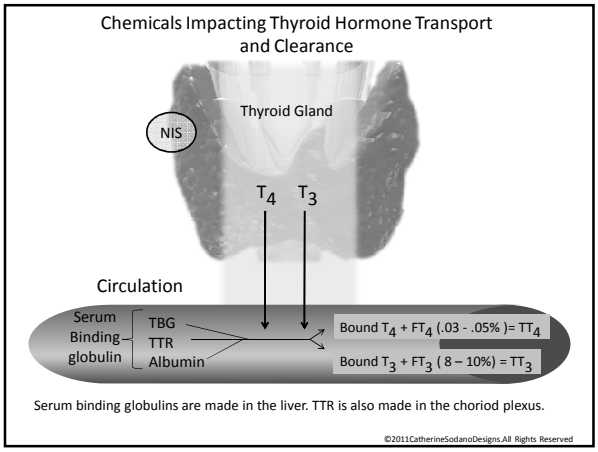
Ways in which chemical affect thyroid function include:

- Alteration of thyroid hormone metabolism
- Direct toxic effect on the gland, changing function and regulation
- Production of thyroid antibodies
- Interaction with thyroid protein carriers
- Blocking iodine uptake by the thyroid gland
- Increasing liver metabolism of the hormone
- Interrupting reception in cells
- Causing tumors
- Suppressing hormone production

Endocrine Disruptors

The Hypothalamus-Pituitary-Thyroid axis is a target of endocrine disrupting chemicals, in particular, polyhalogenated phenolic compounds such as polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs), probably because of their structural resemblance to thyroid hormones.


Mechanisms of Chemical Disruption on Thyroid Function
Thyroid Gland
Thyroglobulin
Tyr Tyr Tyr
NIS
TPO
Thyroglobulin
MIT DIT MIT
TPO
Thyroglobulin
MIT T4 T3 DIT
TPO Inhibitors
6-propyl-2-thiouracil
(used to treat Graves)
Isoflavones (esp Soy)
Genistein
Phytoestrogens
TPO
Heme containing enzyme
TPO decreases with IDA
NIS disruptors
Perchlorates
Thiocyanates
Nitrates
Circulation
Thyroid Hormone Binding Proteins
TBG 75%
Transthyretin
Albumin
T4 T3
NIS – Sodium Iodide Symporter
TPO – Thyroid Peroxidase
Tyr – Tyrosine
MIT – Monoiodothyronine
DIT - Diiodothyronine


Chemicals Impacting Thyroid Hormone Transport and Clearance
Thyroid Gland
NIS
T4 T3
Circulation
Serum Binding globulin
TBG
TTR
Albumin
Bound T4 + FT4 (.03 - .05%)= TT4
Bound T3 + FT3 (8 – 10%) = TT3
Serum binding globulins are made in the liver. TTR is also made in the choriod plexus.
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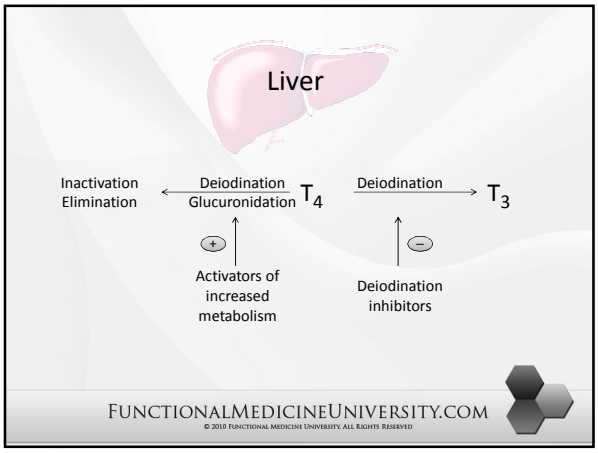
Liver
Inactivation Elimination
Deiodination Glucuronidation
T4
Deiodination
T3
Activators of increased metabolism
Deiodination inhibitors
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Environmental Chemical Influence on Thyroid Hormone Receptors

- It is clear that PCBs are neurotoxic in humans and animals, and that they can interact directly with the thyroid receptor.
- Another environmental toxin of concern is Bisphenol A (BPA).
- Environmental monitoring programs in Europe, Asia, North America, and the Arctic have found traces of several PBDEs in human breast milk, fish, aquatic birds, and elsewhere in the environment.

Other Environmental Toxins of Concern

- Ethylenebisdithiocarbamates (EBDCs) are fungicides used on banana plantation that are linked to thyroid disease, in particular thyroid nodules.
- Heavy metals, such as lead and cadmium have been linked to thyroid gland dysfunction. Both lead and cadmium damage the structure and function of the thyroid gland.

Agents that May Affect TSH Secretion

- Increase serum TSH concentration and/or its response to TRH
- Decrease serum TSH concentration and/or its response to TRH
- Log on to www.scorecard.org to get an in-depth pollution report for your area of interest. Just enter the zip code.

Testing for Environmental Toxins

0761 Polychlorinated Biphenyls (PCBs) - Serum *Methodology: Gas Chromatography/Mass Spectrometry*

	Results (ppb)	95th Percentile** (ppb)	Lipid Adjusted Results (ng/g lipid)	95th Percentile** (ng/g lipid)
Dioxin-like Polychlorinated Biphenyls				
PCB 118	Not Detected	0.22	N/A	31.3
PCB 126	Not Detected	0.00048	N/A	0.07
PCB 156	Not Detected	0.10	N/A	15.3
PCB 169	Not Detected	0.00027	N/A	0.04
Non-Dioxin-like Polychlorinated Biphenyls				
PCB 74	Not Detected	0.15	N/A	22.3
PCB 138	Detected 0.06 - 0.18*	0.48	Detected 11.9 - 35.6*	75.3
PCB 153	Detected 0.1 - 0.32*	0.62	Detected 19.8 - 63.3*	97.1
PCB 180	Detected 0.27	0.53	Detected 52.4	81.5

Cholesterol	160	<= 200	mg/dL
Triglycerides	134	35 - 160	mg/dL
Total Lipids (calc.)***	5		g/L

Reference: Metametrix Clinical Laboratory, 3425 Corporate Way, Duluth, GA 30096 USA

Functional Medicine Laboratory Tests to consider

- Porphyrins Profile
- PCBs Profile
- Chlorinated Pesticides Profile
- Volatile Solvents Profile
- Phthalates & Parabens Profile
- Nutrient & Toxic Elements
- Toxic Metals

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Reference: Metametrix Clinical Laboratory, 3425 Corporate Way, Duluth, GA 30096 USA

Proposed Serological Markers for Body Toxicity

- Gamma-glutamyltransferase (GGT)
- Uric acid
- Homocysteine

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Treatment for Environmental Toxins (Lowering Total Body Burden)

Four Steps to Detoxification

- Mobilizing stored toxins
- Supporting liver metabolism
- Elimination from the body
- Avoiding re-exposure to toxins

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Endocrine Disruptors as Obesogens

The root cause of obesity was thought to be prolonged positive energy balance, that is, too much food and too little exercise. Recent research implicates environmental risk factors, including nutrient quality, stress, fetal environment and pharmaceutical or chemical exposure as relevant contributing influences.

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Classification of Obesogens

- Environmental Pollutants
- Nutritional compounds
- Pharmaceuticals

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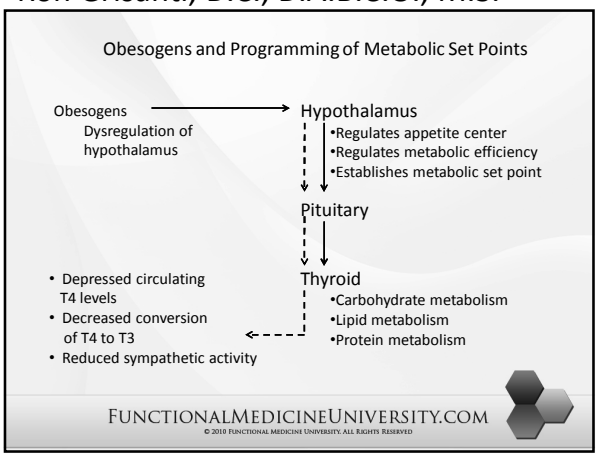
Obesogens and Programming of Metabolic Set Points
Obesogens
Dysregulation of hypothalamus
Hypothalamus
•Regulates appetite center
•Regulates metabolic efficiency
•Establishes metabolic set point
Pituitary
Thyroid
•Carbohydrate metabolism
•Lipid metabolism
•Protein metabolism
• Depressed circulating T4 levels
• Decreased conversion of T4 to T3
• Reduced sympathetic activity
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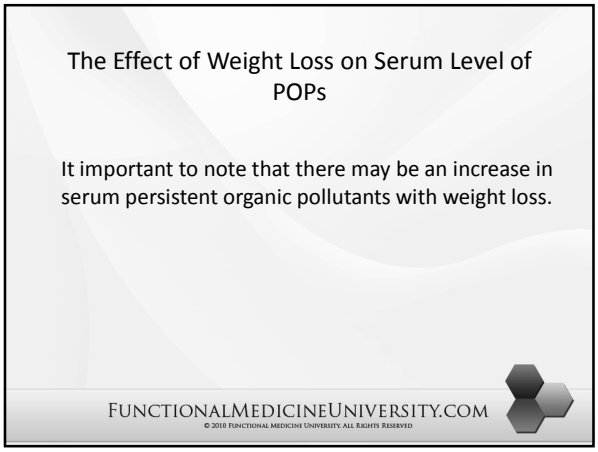
The Effect of Weight Loss on Serum Level of POPs
It important to note that there may be an increase in serum persistent organic pollutants with weight loss.
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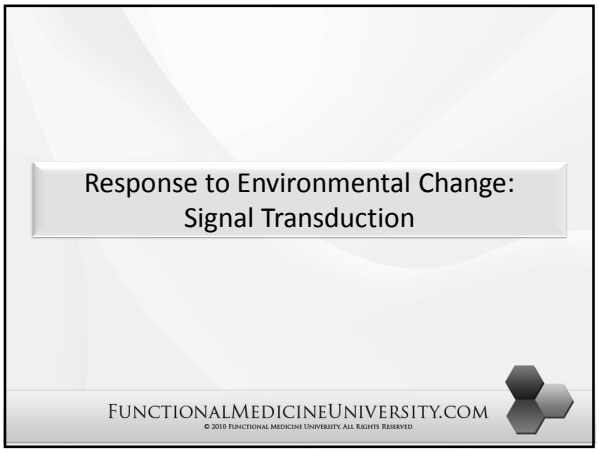
Response to Environmental Change: Signal Transduction
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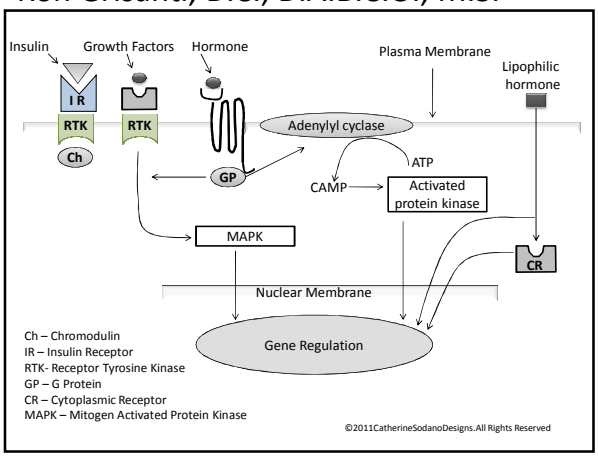

Cross talk between the Plasma Membrane and the Nuclear Pathways

- Cross talk between members of nuclear receptor super family appear to multiply the possible modes of gene regulation.
- From a functional medicine perspective, you must consider the potential interaction of thyroid hormones and estrogens on both nuclear receptors and the membrane-initiated molecular mechanisms of hormone signaling.

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Non-Genomic Actions of Thyroid Hormones

Some of the non-genomic actions of thyroid hormone include increased activity of sodium, potassium and calcium ions

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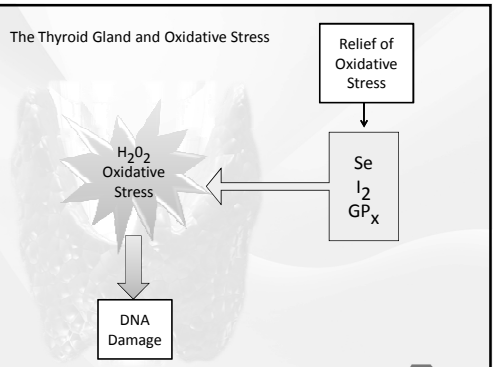
High Levels of Estrogen and Thyroid Hormone

High levels of estrogen (Hyperestrogenemia) increases the serum concentration of thyroid binding globulin limiting the amount of free (active) thyroid hormone to enter the target cells

The Thyroid Gland and Oxidative Stress



Selenium /Iodine/Zinc

Please refer to prior lessons for a complete description of iodine and selenium.

- Module7 (FDMT 563A) Physiology of the Thyroid Gland – Selenium
- Module 7 (FDMT 561D) The Biochemical Effects of Iodine

Selenium

The effect of selenium on autoimmune thyroiditis, as well as many other autoimmune diseases, such as rheumatoid arthritis and lupus, is well documented.

Iodine

Serum Tg was found to be a suitable marker for iodine nutrition status

Influence of thyroid status and iodine intake on serum TG[54]

	Iodine Intake	Serum Tg Concentration
Normal Thyroid Function	Deficiency Adequate Excess	Increased Normal Normal or increased
Hypothyroidism	Deficiency Adequate Excess	Deceased Decreased Decreased
Hyperthyroidism	Deficiency Adequate Excess	Increased Increased Increased

The Paradox of Iodine Intake and thyroid Autoimmunity

A sudden increase in iodine intake in an iodine – deficiency population may induce enhanced thyroid autoimmunity.

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Thyroid Hormones and Oxidative Stress

- Thyroid hormones influence several mitochondrial functions including oxygen consumption and oxidative phosphorylation, and to increase the metabolic activity of almost all tissues of the body.
- Thyroid hormone has a pro-oxidant effect and increases the oxygen free radical production and hence the resultant decrease in antioxidant state in the case of hyperthyroidism when compared to the normal and hypothyroidism

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Oxidative Stress, Thyroid Hormone Status and Diabetes

Failure to recognize the presence of thyroid dysfunction in diabetics may be a primary cause of poor management often encountered in the treatment of diabetes.

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'Thyroid Diabetes'

- Hyperthyroidism and Glucose Regulation
- Hypothyroidism and Glucose Regulation

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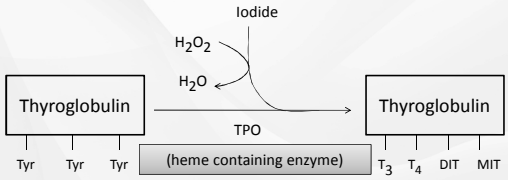
The Effect of Iron Deficiency on Thyroid Function



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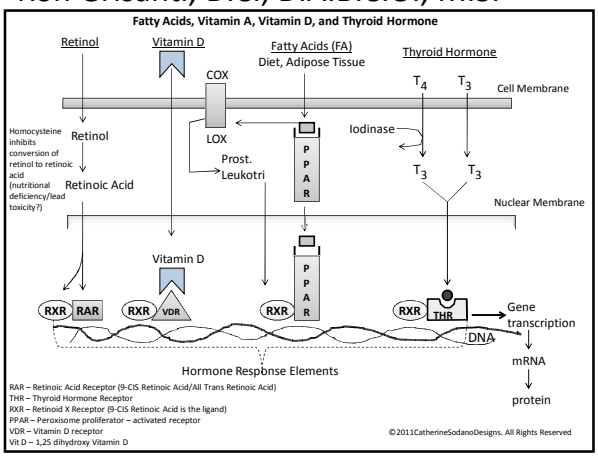
	FERRITIN	IRON	TIBC	%TRANSFERRIN SATURATION
CHRONIC BLOOD LOSS	L	L	H	L
ACUTE BLOOD LOSS	N	L	N	L
IRON DEFICIENCY	L	L	E	L
HEMOLYTIC ANEMIA	H	H	L	H
CHRONIC DISEASE	H	L	L	L
HEMOCHROMATOSIS	H	H	L	H
PREGNANCY	L	L	H	L
ESTROGEN THERAPY	N	H	H	L
ACUTE INFLAMMATION	H	N	L	H
IRON TOXICITY	H	H	N	H
IRON EXCESS	N(optimal)	N(optimal)	N(optimal)	H (Greater than 45%)
IRON DEPLETION	L (20ug/L) Low optimal	N (optimal)	N(ref) H(optimal)	N (optimal)
IRON DEFICIENCY WITHOUT ANEMIA	L(optimal) N (ref)	L (optimal) N(ref)	H (optimal) N (ref)	L(optimal) N (ref)

Change optimal serum iron to 65 – 115 ug/dL



The Physical Signs of Vitamin A Deficiency Include:

- Dry, scaly skin
- Follicular hyperkeratosis
- Night blindness
- Xerophthalmia
- Psoriasiform rash

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Vitamin D and Autoimmunity

- The vitamin D-mediated endocrine system plays a role in the regulation of calcium homeostasis, cell proliferation, and (auto) immunity.
- Polymorphic sites tested at the vitamin D receptors were found to be associated with a higher risk of Hashimoto's thyroiditis.

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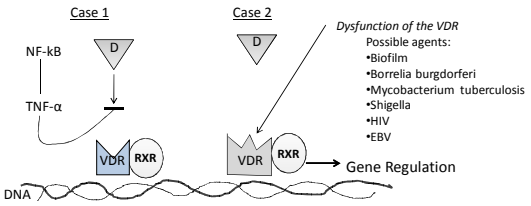
Dysregulation of Vitamin D and of the Vitamin D Receptor



D – 1,25 Dihydroxy Vitamin D
VDR – Vitamin D receptor
RXR – Retinoid X receptor

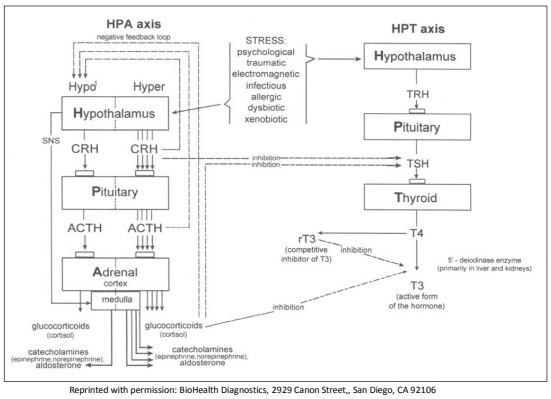
Functional Medicine Testing for Fat-Soluble Vitamin

0036 Fat-Soluble Vitamin Profile *Methodology: High Performance Liquid Chromatography*

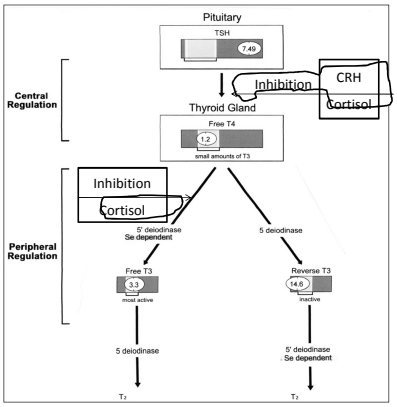
Ranges: Ages 13 and over

	Results	Quintile Ranking (1st 2nd 3rd 4th 5th)	95% Reference Interval	
Vitamin A				
Retinol	0.56	0.36 – 0.74	0.29 - 1.05	mg/L
β-Carotene	0.95	0.15 – 1.70	0.10 - 2.71	mg/L
Vitamin E				
alpha-Tocopherol	8.6 L	9.8 – 25.1	6.8 - 31.7	mg/L
gamma-Tocopherol	0.66	0.26 – 2.06	0.06 - 2.99	mg/L
Vitamin D				
25-Hydroxyvitamin D	47	19 – 33	12 - 83	ng/mL
Vitamin K				
Undercarboxylated osteocalcin (ucOC)	3.3 H	3.1	<= 6.2	ng/mL
Coenzyme Q10	1.41	0.64 – 2.16	0.48 - 3.04	mg/L

HPA-HPT Axes



Reprinted with permission: BioHealth Diagnostics, 2929 Canon Street,, San Diego, CA 92106



Reference: Genova Diagnostics, 63 Zillicoa Street, Asheville, NC 28801

The Thyroid - Adrenal Connection

- Low Metabolic Energy
- Contributors to low metabolic energy include:
  - Thyroid dysfunction
  - Adrenal dysfunction
  - Nutritional deficiency
  - Oxidative Stress
  - Environmental toxins
  - Other Hormonal imbalances

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Adrenal Thyroid Symptom Questionnaire

This questionnaire can be located in the download library at :

www.FunctionalMedicineUniversity.com

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Assessing Metabolic Energy via Temperature Graph Plotting

- Functional thyroid activity can be estimated by measuring basal body temperature, which is an indicator of basal metabolic rate.
- *Please keep in mind that low basal body temperature plotting is not an exact science. Patients may present with normal body temperature and still have hypothyroidism due to adrenal compensation. The temperature graph is not a substitute for a comprehensive history, physical exam and lab testing.*

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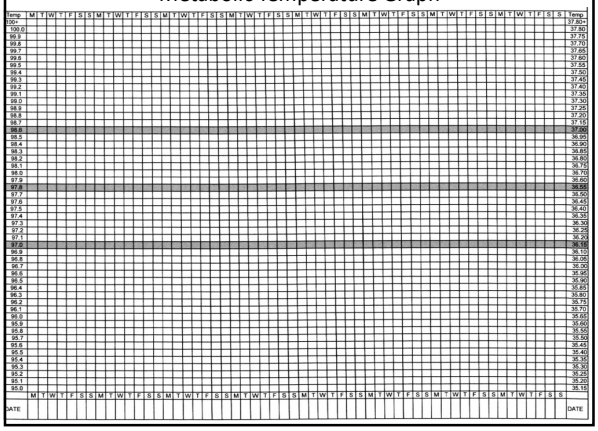
Metabolic Temperature Graph



Interpreting the Temperature Graph as a Guideline

- Stable but low temperature
- Considerable variability and instability (sharp and spiking)
- Rising in average temperatures (stable or unstable)
- Increase in variability – an expansion pattern
- Contracting/Rising pattern – a sign of improvement

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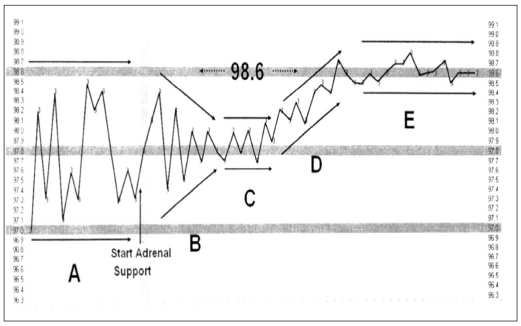
Sample Temperature Graph of Proper Adrenal Support



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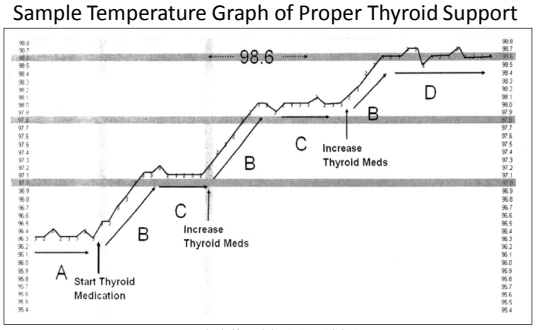
Sample Temperature Graph of Proper Thyroid Support



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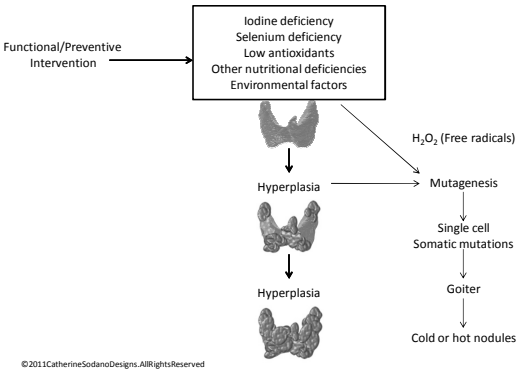
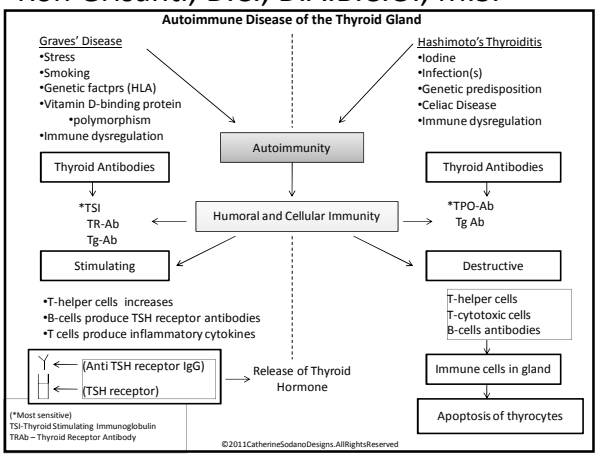
(Keep in mind that temperature improvement can occur without thyroid replacement therapy. A proper detoxification program and/or optimizing adrenal function can normalize the temperature.)

Proposed Functional Etiology of Thyroid Dysfunction





Hypothyroidism

- Primary (Overt) Hypothyroidism
- Central Hypothyroidism (secondary or tertiary)

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Subclinical Hypothyroidism and Sub-Laboratory Hypothyroidism

- Subclinical hypothyroidism (SCH), also called thyroid failure, is diagnosed when peripheral thyroid hormone levels are within normal reference laboratory reference range but serum thyroid-stimulating hormone (TSH) levels are mildly elevated.
- **Individuals with subclinical hypothyroidism do not present with symptoms.**
- Sub-Laboratory refers to a patient who presents with a clinical history, physical examination and altered basal body temperature indicating thyroid dysfunction; however their **laboratory tests are normal**.

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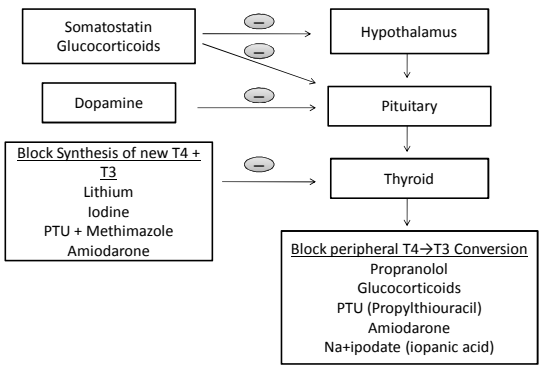
Nonthyroidal Illness Syndrome

- The evaluation of altered thyroid function parameters in systemic illness and stress remains complex because changes occur at all levels of the hypothalamic-pituitary-thyroid axis.
- Alterations in Lab Tests with (NTIS)
  - Low T3
  - T4 – Generally decreases
  - – rT3 is usually elevated
  - TSH is usually within normal reference range
- Thyroid hormone dysregulation in specific clinical conditions
  - Starvation and fasting
  - Infectious disease
  - Cardiac disease
  - Renal disease
  - Hepatic disease

Drugs that Affect Thyroid Function



Subclinical Hyperthyroidism

- Subclinical hyperthyroidism is characterized by a low or undetectable TSH with free T3 and free T4 in the normal reference ranges.
- Subclinical hyperthyroidism may be caused by exogenous or endogenous factors
- From a functional medicine perspective, it seems reasonable to perform a nutritional assessment (e.g. antioxidants, iron, selenium, etc.), and assess for oxidative stress and environmental toxins.

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Thyroid Hormone Resistance (THR)

- Resistance to thyroid hormone has been classified as a rare autosomal dominant inherited syndrome of reduced end-organ responsiveness to thyroid hormone.
- Mutations in the thyroid receptor appear to be involved. Some authorities classify THR as a condition similar to insulin resistance.
- The common clinical presentation of THR includes:
  - Elevated free T4 and free T3, and normal to slightly elevated TSH
  - Goiter
  - Absence of the usual symptoms and metabolic consequences of thyroid hormone excess

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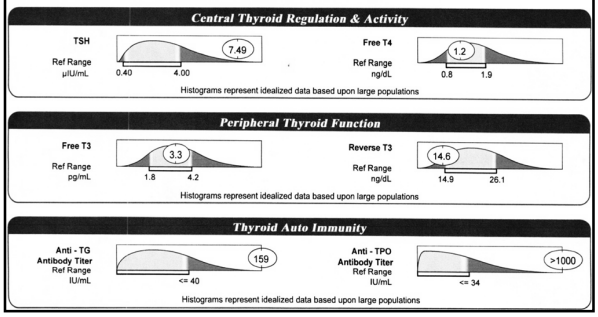
Laboratory Thyroid Assessment

It is always important that the clinical situation be taken into consideration when thyroid function test are interpreted. In other words, **treat the patient not the lab test.**



Thyroid Panel

	Lab Range	Optimal Range
TSH	0.4 – 5.5 mIU/L	1.3 – 2.0 mIU/L
Total T4	4.5 – 12.5 µg/dL 57 – 148 mnol/L	6.0 – 11.9 µg/dL 77 – 154 nmol/L
Total T3	80 – 230 ng/dl 1.23 – 3.53 nmol/L	90 – 168 ng/dl 1.4 – 2.6 nmol/L
Free T3	2.3 – 4.8 ng/dl 230 – 480 pg/dl	3.0 – 3.25 ng/dl 300 – 325 pg/dl
Free T4	0.7 – 2.4 ng/dL 9 -30 pmol/L	1.0 – 1.5 ng/dL 12.9 – 19.3 pmol/L
Reverse T3	11 – 32 ng/dl 0.11 – 0.32 ng/ml	14.9 -26.7 ng/dl 0.15 – 0.27 ng/ml

General Interpretation of Thyroid Function Test

	TSH	Free T4 or Free T3	Free T4 and FreeT3	Free T4	Free T3
Thyroid hormone resistance	N	H			
Recent ingestion of thyroid hormone	N	H			
Euthyroid	N		N		
Pituitary hyperthyroidism	H	H			
Subclinical hypothyroidism	H		N		
Primary hypothyroidism	H	L			
Pituitary hypothyroidism	N	L			
Nonthyroidal illness	N	L			
Primary Hyperthyroidism	L	H			
Subclinical Hyperthyroidism	L		N		
Medication (Dopamine)	L		N		
Medication (Glucocorticoids)	L			N	L

Free T4: Free T3

Both TRH and TSH are subject to negative feedback of T4 and T3 on the hypothalamus and pituitary respectively. The "normal" serum ratio of T4 to T3 is 4-5:1 (peripheral conversion of T4 to T3 is factored into the ratio of T4 to T3).

[Note: free T 4 is measured in nanograms/dL and free T3 is measured in pictograms/dL. Nanograms must be converted to pictograms to obtain the correct values to compare the T4:T3 ratio. One nanogram equals 1000 picograms. Example:

T4 labs results (1.2 ng/dL)

T3 lab results (240 pg/dL)

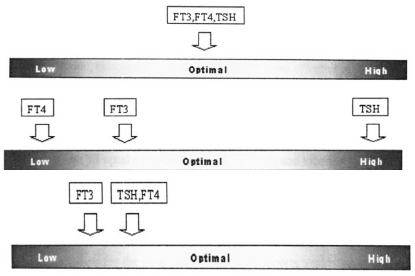
Calculations;

1. 1.2 ng/dl times 1000 pg/1 ng equals 1200 pg/dL of Free T4
2. 1200 pg/dL of T4 divided by 240 pg/dl equals 5
3. 5:1 ratio of free T4 to free T3

State of Health	Normal 4-5:1 ratio of T4:T3	Increased T4:T3 ratio	Decreased T4:T3 ratio
optimal	x		
Nonthyroidal illness		x	
Iodine deficiency			x
T3 thyrotoxicosis			x
Amiodarone (antiarrhythmic medication)		x	

The Functional Medicine Thyroid Scale

The Thyroid Scale is a tool that analyses TSH, Free T4 and Free T3 from a functional medicine perspective. Each analyte is plotted on the scale and compared to one another. By relating the analytes, they can be view under the functional medicine "lens".



Thyroid Scale Diagram - Healthy

Labs	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8
TSH	0.26–0.33	0.34 - 0.41	0.42 - 0.49	0.50 - 0.65	0.66 - 0.81	0.82– 0.97	0.98 - 1.13	1.14 - 1.29	1.30 - 1.80	1.81 - 2.20	2.21 - 2.60	2.61 - 3.00	3.01 - 4.00	4.01 - 5.00	5.01 - 6.00	6.01– 8.00	8.01– 10.0
FT4	0.40– 0.49	0.50 - 0.59	0.60– 0.69	0.70– 0.79	0.80– 0.89	0.90 - 0.99	1.00 - 1.09	1.10 - 1.19	1.20 - 1.30	1.31 - 1.40	1.41 - 1.50	1.51 - 1.60	1.61 - 1.70	1.71 - 1.80	1.81 - 1.90	1.91– 2.00	2.01– 2.10
FT3	176 - 193	195 - 211	212 - 229	230 - 247	248 - 265	266 - 283	284 - 301	302 - 319	320 - 330	331 - 348	349 - 366	367 - 384	385 - 402	403 - 420	421 - 438	439 - 456	457 - 474

Thyroid Scale Diagram - Hypothyroid

Labs	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8
TSH	0.26–0.33	0.34 - 0.41	0.42 - 0.49	0.50 - 0.65	0.66 - 0.81	0.82– 0.97	0.98 - 1.13	1.14 - 1.29	1.30 - 1.80	1.81 - 2.20	2.21 - 2.60	2.61 - 3.00	3.01 - 4.00	4.01 - 5.00	5.01 - 6.00	6.01– 8.00	8.01– 10.0
FT4	0.40– 0.49	0.50 - 0.59	0.60– 0.69	0.70– 0.79	0.80– 0.89	0.90 - 0.99	1.00 - 1.09	1.10 - 1.19	1.20 - 1.30	1.31 - 1.40	1.41 - 1.50	1.51 - 1.60	1.61 - 1.70	1.71 - 1.80	1.81 - 1.90	1.91– 2.00	2.01– 2.10
FT3	176 - 193	195 - 211	212 - 229	230 - 247	248 - 265	266 - 283	284 - 301	302 - 319	320 - 330	331 - 348	349 - 366	367 - 384	385 - 402	403 - 420	421 - 438	439 - 456	457 - 474

Interpretive Guide for the Thyroid Scale

State of Health	TSH	Free T4	Free T3	Temperature Pattern
Healthy	optimal	optimal	optimal	Stable /normal
Adrenal Fatigue	low	low	low	Low , very unstable
Estrogen dominance	low	low	low	Low, very unstable
Primary hypothyroidism	High	Low	Low but to the right of T4	Low and stable
Hypothyroidism due to pituitary dysfunction	Low	Low	Low but to the right of T4	Low and stable
Late Hashimoto's Thyroiditis or Hypothyroidism and adrenal fatigue	Optimal to high	low	Low and mildly to the right of T4	Low and unstable
Early Hashimoto's Thyroiditis	Very low	high	High but to the left of T4	Variable
Grave's Disease	Very low	Very high	Very high and to the right of T4	Tends to be high and stable early and then becomes low and unstable
Thyroid hormone resistance	Mildly high	high	High and to the right of T4	Low and mostly stable. Assess for nutritional deficiency, toxic burden, mitochondrial cytopathy
Chronic infection	Optimal to mildly high	Optimal to mildly high	Optimal to mildly high	Mildly elevated
Iron deficiency	high	low	low	Iron deficiency is thought to impair thyroid peroxidase activity causing a decrease in synthesis of thyroid hormones.

Thyrotropin-Releasing Hormone Stimulation Test

TRH stimulation test is useful in the diagnosis of central hypothyroidism, especially in whom free T4 and/or TSH is low-normal and known to have hypothalamic-pituitary pathology.

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Thyroid Hormone Replacement

- Synthyroid
  - Synthetic T4
  - Narrow therapeutic index
  - Contraindicated for adrenal insufficiency; underlying CVD
  - Many drug interactions
  - May still have problems with peripheral conversion of T4 to T3
- Cytomel (Liothyronine Sodium) (T3)
  - 25 mcg is equal to approx 1 grain of desiccated thyroid
- Armour Thyroid (thyroid tablets USP)
  - Non-synthetic
  - T4 and T3 (4.2 parts T4 to one part T3)
  - For some patients -best taken in two divided doses

Side Effects, Interventions, Contraindications, & Absorption Issues

- All thyroid medications have similar actions in the body
- Look for signs/symptoms of hyperthyroidism
  - Tremor
  - Heat intolerance
  - Cardiovascular
  - Gastrointestinal
  - Hair loss
- Drug interactions
  - Estrogens
  - Anticoagulants
  - Beta blockers
  - Theophylline
  - Cholestyramine
- Contraindications
  - Obesity
  - CVD
  - Hyperthyroidism
  - Addision's disease/adrenal insufficiency
- Absorption impaired by
  - Antacids
  - Hydroxides
  - Calcium carbonate
  - Ferrous sulfate
  - Bile acid sequestrants

Thyroid Hormone Replacement Conversion Chart

Drug	Thyrolar (synthetic T3-T4 1:4 per tablet)	Liothronine (Cytomel) T3	Levothyroxine (Synthroyd)	Desiccated Thyroid (Armour Thyroid)	Supplement	Supplement Desiccated T4/T3 1 cap= 42 mg
	3.1 mcg/12.5mcg		25 mcg 0025 mg	15 mg ¼ grain	5-10 mg	21.0 mg ½ cap
	6.25 mcg/25mcg	12.5 mcg	50 mcg .05 mg	30 mg ½ grain	20 mg	31.5 mg ¾ cap
	12.5mcg/50mcg	25 mcg	100 mcg .1 mg	60 mg 1 grain	30 mg	73.5 mg 1 ¾ cap
	18.75mcg/75mcg	37.5 mcg	150 mcg .15 mg	90 mg 1 ½ grains	40 mg	93.5 mg 2 ¼ cap
	25mcg/100mcg	50 mcg	200 mcg .2 mg	120 mg 2 grains		
	37.5mcg/150mcg	75 mcg	300 mcg .3 mg	180 mg 3 grains		

Precautions of Thyroid HRT

- Side Effects may include:
  - Anxiety
  - Nervousness
  - Insomnia
  - Palpitations
  - Rapid pulse
  - Pain or tightness in the chest
- Thyroid Hormone and Hypoadrenalism
  - In patients in whom hypothyroidism and severe hypoadreanlism coexist, administration of thyroid hormone prior to correcting adrenal insufficiency can trigger an "adrenal crisis".

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Functional Medicine Approach to Treating Thyroid Dysfunction and Balancing the HPT and HPA Axes Check List:

- Nutritional status
- Gastrointestinal Status
- Adrenal Gland status
- Liver status
- Immune status
- Environmental toxin exposure
- Oxidative Stress Status
- Medications
- Thyroid Medication

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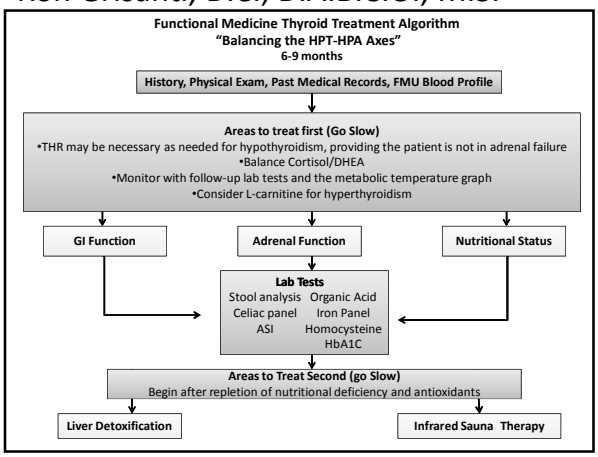
Functional Medicine Thyroid Treatment Algorithm
"Balancing the HPT-HPA Axes"
6-9 months
History, Physical Exam, Past Medical Records, FMU Blood Profile
Areas to treat first (Go Slow)
•THR may be necessary as needed for hypothyroidism, providing the patient is not in adrenal failure
•Balance Cortisol/DHEA
•Monitor with follow-up lab tests and the metabolic temperature graph
•Consider L-carnitine for hyperthyroidism
GI Function
Adrenal Function
Nutritional Status
Lab Tests
Stool analysis
Organic Acid
Celiac panel
Iron Panel
ASI
Homocysteine
HbA1C
Areas to Treat Second (go Slow)
Begin after repletion of nutritional deficiency and antioxidants
Liver Detoxification
Infrared Sauna Therapy


Summary
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