Iodine

and

Your Health

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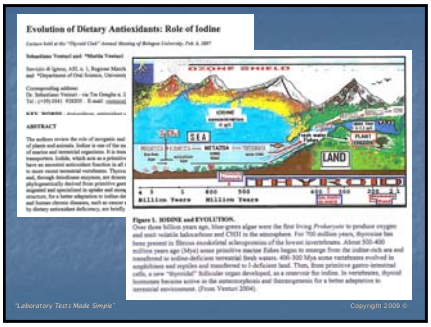
Where does it come from?

Why is it important for our health?

Where does it come from?

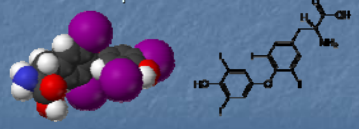
The ocean-algae-phytoplankton-fish

The ocean-atmospheric-rain-plants-lactating mammals-milk



Why is iodine important for our health?

About 65% of thyroxine (T4) is composed of iodine



As a component of thyroid hormones,

Iodine is essential for life

Iodine Deficiency And Iodine Deficiency Disorders (IDD)

Consequences of Iodine Deficiency on the Fetus, Neonate, Child, and Adult

Iodine Deficiency The Fetus

Miscarriage
Stillbirths
Congenital anomalies-cretinism
Brain Damage-mental retardation
Increased perinatal morbidity and mortality

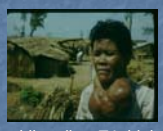
Iodine Deficiency The Neonate

Endemic cretinism
Neonatal Goiter
Neonatal hypothyrodism
Endemic mental retardation

Iodine Deficiency
The Child/Adolescent

Goiter
(Subclinical) Hypothyrodism
School performance and IQs impaired
Retarded growth, hearing, speech

Iodine Deficiency
The Adult

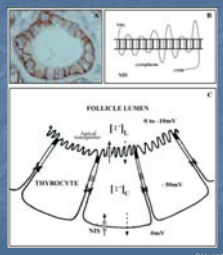


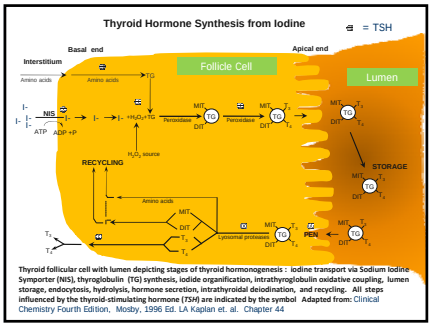
Goiter
Apathy
Overt Hypothyroidism (low T4, high TSH)
Suboptimal brain function (sluggish thinking)
Low capacity for initiative and decision making
Spontaneous Hyperthyroidism
Iodine-induced Hyperthyroidism

The Thyroid Gland:
Thyroid Hormone Synthesis Starting with Iodine

Thyroid Hormone Synthesis from Iodine

Na-Iodine Symporter (NIS)





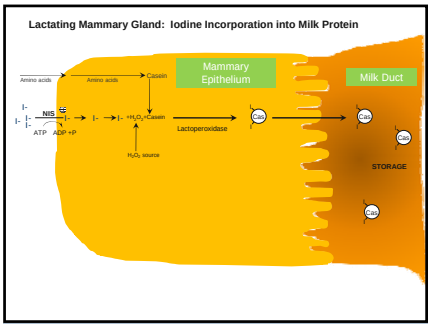
Thyroid follicular cell with lumen depicting stages of thyroid hormonogenesis : iodine transport via Sodium Iodine Symporter (NIS), thyroglobulin (TG) synthesis, iodide organification, intrathyroglobulin oxidative coupling, lumen storage, endocytosis, hydrolysis, hormone secretion, intrathyroidal deiodination, and recycling. All steps influenced by the thyroid-stimulating hormone (*TSH*) are indicated by the symbol Adapted from: Clinical Chemistry Fourth Edition, Mosby, 1996 Ed. LA Kaplan et. al. Chapter 44

What Other Roles Does Iodine Play in the Body?

Uptake of Iodine in Extra-Thyroidal Tissues

Iodine is Concentrated in Many Tissues other than the Thyroid

Salivary Glands	Nasopharynx	Eyes (Lacrimal Gland/Ciliary body)
Stomach	Small and Large Intestinal Mucosa	
Pancreas	Kidneys	Liver
Mammary glands	Placenta	Uterus
Ovaries	Testes	Prostate
Skin	White Blood Cells	



Are you getting enough iodine?

How to assess iodine consumption

Body fluids commonly used to assess iodine status

Urine

>90% of iodine consumed present in urine in 24 hr

Blood

Saliva

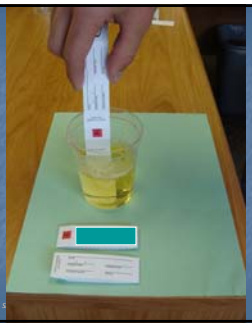
Urinary Iodine-Methods for Testing

Colorimetric: Sandell-Kolthoff reaction

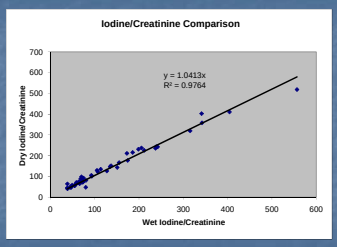
- Chloric Acid Digestion
- Ammonium Persulfate Digestion

ICP/MS

Ion Electrode



Wet vs Dry Urine Iodine Levels (n=77)



How much is enough (sufficient)?

At what level are you considered deficient?

At what level are you considered excessive?

Optimal Iodine Intake for Thyroid and Extra-Thyroidal Tissues

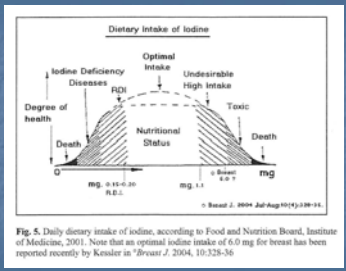
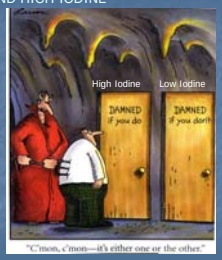


Fig. 5. Daily dietary intake of iodine, according to Food and Nutrition Board, Institute of Medicine, 2001. Note that an optimal iodine intake of 6.0 mg for breast has been reported recently by Kessler in "Breast J. 2004, 10:328-36

THYROID DYSFUNCTION OCCURS WITH BOTH LOW AND HIGH IODINE



Assessment of Iodine Sufficiency Status by Measurement of Urinary Iodine

Table 7. Epidemiological criteria for assessing iodine nutrition in a population based on median and/or range of urinary iodine concentrations (from ref.1).

Median urinary iodine (µg/L)	Iodine intake	Iodine nutrition
School-aged children		
<20	Insufficient	Severe iodine deficiency
20-49	Insufficient	Moderate iodine deficiency
50-99	Insufficient	Mild iodine deficiency
100-199	Adequate	Optimal
200-299	More than adequate	Risk of iodine-induced hyperthyroidism in susceptible groups
>300	Excessive	Risk of adverse health consequences (iodine-induced hyperthyroidism, autoimmune thyroid disease).
Pregnant women		
< 150	Insufficient	
150 - 249	Adequate	
250 - 499	More than adequate	
≥ 500	Excessive*	
Lactating women†		
< 100	Insufficient	
≥ 100	Adequate	
Children less than 2 years old		
< 100	Insufficient	
≥ 100	Adequate	

* The term "excessive" means in excess of the amount required to prevent and control iodine deficiency.
† In lactating women, the figures for median urinary iodine are lower than the iodine requirements because of the iodine excreted in breast milk.

WHO Recommendations to Achieve Iodine Sufficiency

Table 11. Tolerable upper intake level for iodine (µg/day)

Age group	EC/SCF, 2002	IOM, 2001
1-3 years	200	200
4-6 years	250	300
7-10 years	300	300
11-14 years	450	300
15-17 years	500	900
Adult	600	1100
Pregnant women >19 years	600	1100

http://www.who.int/gb/ebwha/pdf_files/WHA58/WHA58_24-en.pdf

"Iodine deficiency impairs thyroid function. Similarly, iodine excess, including overcorrection of a previous state of iodine deficiency, can also impair thyroid function. The effect of iodine on the thyroid gland is complex with a U-shaped relation between iodine intake and risk of thyroid diseases. Both a low and high iodine intake are associated with an increased risk of thyroid disorders. Healthy adults can tolerate up to 600-1100 ug iodine/day without any side effects."

Thresholds for Iodine Deficiency

Classification of Iodine Deficiency	Urinary Iodine ug/L	ug/g creatinine
No ID	158	150
Marginal ID	126	124
Mild ID	101	100
Intermediate ID	76	75
Moderate ID	50	51
Severe ID	25	25

C Als et.al. Eur J Clin Nutr 57: 1181-1188, 2003. Quantification of urinary iodine: a need for revised thresholds

Iodine Toxicity
Symptoms of Chronic Exposure

Coryza (head cold symptoms)
Salivary gland swelling (increased salivation)
Gastrointestinal irritation
Acneform dermatitis (Ioderma)
Metallic taste
Gingivitis
Conjunctivitis and oedema of eye lids

Goodman and Gilman, 1970, In Pharmacological basis of therapeutics

Wolff-Chaikoff Effect (Mechanism)

Excessive iodine intake inhibits the formation of iodinated tyrosine on thyroglobulin, lowers the T4 and T3 plasma levels and raises plasma TSH. These effects are transient and most individuals escape the Wolff-Chaikoff effect within about 48 hrs. A minority of individuals do not escape with persistent exposure to high iodine and develop goiter and become hypothyroid.

Iodine-Induced Hyperthyroidism-IIH

In iodine-induced hyperthyrodism excess hormone is produced. This occurs especially in areas with endemic goitre or IDD, after iodine supplementation is introduced in the diet. In areas where iodine is NOT deficient, IIH is rare with iodine intake of < 5 mg/day (e.g. Japan)

Iodine Toxicity
Iodine-Induced Hyperthyroidism-IIH

" IIH is an occasional consequence of the correction of iodine deficiency, occurring most frequently in older subjects with multinodular goiter. This complication is usually mild and self-limited, but may be serious and occasionally lethal. The most important clinical manifestations are cardiovascular. Thyrotoxicosis can aggravate pre-existing cardiac disease and can also lead to atrial fibrillation, congestive heart failure, worsening of angina, thromboembolism, and rarely, death. In the absence of preexisting cardiac disease, treatment of thyrotoxicosis usually returns cardiac function to normal. ....Monitoring should be an important part of a successful program of iodization....IIH, while an issue that needs serious address, is not a reason to stop iodine supplementation in deficient regions "

Dunn JT et.al. The Prevention and Management of Iodine-Induced Hyperthyroidism and its Cardiac Features. Thyroid 8 (1), 101-106, 1998.

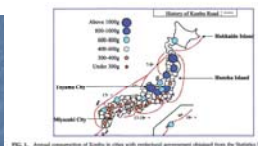
Iodine and Breast Health

Iodine Intake in Populations with Low Breast Cancer Risk

THYROID
Volume 18, Number 6, 2008
© Mary Ann Liebert, Inc.
DOI: 10.1089/thy.2007.0379

The Average of Dietary Iodine Intake due to the Ingestion of Seaweeds is 1.2 mg/day in Japan

" Total consumption of Konbu in Japan is 20,000 tons per year by dry weight. Since the population of Japan is 130 million, the iodine intake by the ingestion of Konbu is 1.26 mg/d per person."



Are women in the US placing themselves at higher lifetime risk for breast cancer by eating a low iodine vegan diet?

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Vegans in the US are at Risk for Iodine Deficiency

Iodine Status and Thyroid Function of Boston-Area Vegetarians and Vegans

Angela M. Leung, Andrew Lakdar, Xuemei He, Lewis E. Braverman, and Elizabeth N. Pearce

TABLE 2. Concentrations [medians (ranges)] of urinary iodine, perchlorate, and thiocyanate and serum thyroid function of entire data set

	Vegetarians (n = 78)	Vegans (n = 62)	P
Urinary iodine (μg/liter)*	147.0 (9.3–779.0)	75.5 (6.8–964.7)	<0.01
Urinary perchlorate (μg/liter)*	4.6 (0.2–42)	3.6 (0.2–258)	0.75
Urinary thiocyanate (μg/liter)*	341 (31–1963)	630 (108–3085)	<0.01
Urinary cotinine (ng/ml)*	0.22 (0–2849)	0.10 (0–3394?)	0.34
TSH (mU/liter)*	1.38 (0–3.52)	1.10 (0.14–6.81)	0.46
FT4 (ng/dl)*	1.29 (0.95–1.66)	1.24 (0.92–1.67)	0.77

*n = 77 (vegetarians) and n = 62 (vegans) due to missing data.
†n = 76 (vegetarians) and n = 60 (vegans) due to missing data.

Smoking confirmed by urinary cotinine levels; and thiocyanate-rich food consumption, median urinary thiocyanate concentration of vegans (630 μg/liter; range 108–3085 μg/liter) was higher than vegetarians (341 μg/liter; range 31–1963 μg/liter) ($P < 0.01$). There were no between-group differences in urinary perchlorate concentrations ($P = 0.75$). TSH ($P = 0.46$), and free T_4 ($P = 0.77$), urinary iodine, perchlorate, and thiocyanate levels were not associated with TSH ($P = 0.39$) or free T_4 ($P = 0.14$), even when adjusted for multiple variables.

Conclusions: U.S. vegetarians are iodine sufficient. U.S. vegans may be at risk for low iodine intakes, and vegan women of child-bearing age should supplement with 150 μg iodine daily. Environmental perchlorate and thiocyanate exposures are not associated with thyroid dysfunction in these groups. (J Clin Endocrinol Metab 96: E980–E986, 2011)

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Are women in the US placing their unborn and breast feeding children at higher lifetime risk for mental deficits by eating a low iodine vegan diet?

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Iodine Deficiency and Development of Brain

Iodine is a trace element essential for the synthesis of triodothyronine (T_3) and thyroxine (T_4). Inadequate intake of iodine leads to insufficient production of these hormones, which play a vital role in the process of early growth and development of most organs, especially the brain. The neurological sequele of iodine deficiency are mediated by thyroid hormone deficiency, varying from minimal brain function to a syndrome of severe intellectual disability. All the basic processes of neurogenesis: cellular proliferation, differentiation, migration, and selective cell death are impaired during period of brain growth spurt. Evidence suggests alterations in synaptology, neurons, myelin sheaths, glial cells, and, morphology of cerebrum and cerebellum in severe iodine deficiency. Foetal thyroid ontogenesis occurs after the first trimester. Until then foetus is dependent on maternal T_4. A thyroid dependent event important for subsequent brain development occurs in the beginning of the third trimester of pregnancy

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From: UNICEF...unicef.org and prevention of childhood diseases

When a foetus does not receive adequate iodine, the developing brain cannot establish as dense a network of interconnections among the main brain cells and intellectual capacity is compromised for life. In extreme cases children can suffer severe mental retardation, but even where iodine deficiency is less severe all children suffer a reduction of 10-15 percent in learning ability at school. Iodine Deficiency Disorders (IDD) are rightly recognized as the world's leading preventable mental and development disabilities.

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Studies show iodine is protective of the breast and reproductive tissues

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Animal Studies Suggest Iodine from High-Iodine Foods or Supplements May Be Breast Protective

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RAPID COMMUNICATION Jpn. J. Cancer Res. 92, 483–487, May 2001

Seaweed Prevents Breast Cancer?

Hiroomi Funahashi,[1,4] Tsuneo Imai,[1] Takahiro Mase,[1] Masanori Sekiya,[1] Kazuki Yokoi,[1] Hiromichi Hayashi,[1] Ayhiro Shibata,[1] Takako Hayashi,[1] Mikiko Nishikawa,[1] Namiko Suda,[1] Yutsuka Hibi,[1] Yutaka Mizuno,[2] Kyosuke Tsukamura,[3] Akemi Hayakawa[3] and Seiichi Tamura[3]

[1]Department of Surgery II and [2]Equipment Center for Research and Education, Nagoya University School of Medicine, 65 Tsurumai-cho, Showa-ku, Nagoya 466-8550 and [3]Department of Biochemistry, Faculty of Pharmaceutical Sciences, Science University of Tokyo, 12 Ichigaya Funagawara-machi, Shinjuku-ku, Tokyo 162-0826

To investigate the chemopreventive effects of seaweed on breast cancer, we have been studying the relationship between iodine and breast cancer. We found earlier that the seaweed, wakame, showed a suppressive effect on the proliferation of DMBA (dimethylbenzanthracene)-induced rat mammary tumors, possibly via apoptosis induction. In the present study, powdered *mekabu* was placed in distilled water, and left to stand for 24 h at 4°C. The filtered supernatant was used as *mekabu* solution. It showed an extremely strong suppressive effect on rat mammary carcinogenesis when used in daily drinking water, without toxicity. *In vitro*, *mekabu* solution strongly induced apoptosis in 3 kinds of human breast cancer cells. These effects were stronger than those of a chemotherapeutic agent widely used to treat human breast cancer. Furthermore, no apoptosis induction was observed in normal human mammary cells. In Japan, *mekabu* is widely consumed as a safe, inexpensive food. Our results suggest that *mekabu* has potential for chemoprevention of human breast cancer.

Key words: Breast cancer — Chemoprevention — *Mekabu* (seaweed) — Apoptosis

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RAPID COMMUNICATION Jpn. J. Cancer Res. 92, 483–487, May 2001

Seaweed Prevents Breast Cancer?

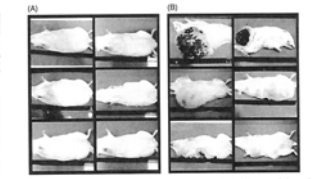

Fig. 3. Mammary tumors were not observed macroscopically in rats of the *mekabu* group (A) despite huge tumors in the control group (B).

Key words: Breast cancer — Chemoprevention — *Mekabu* (seaweed) — Apoptosis

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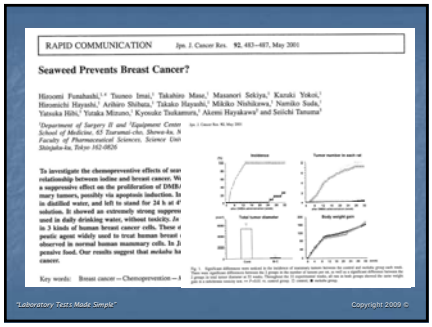
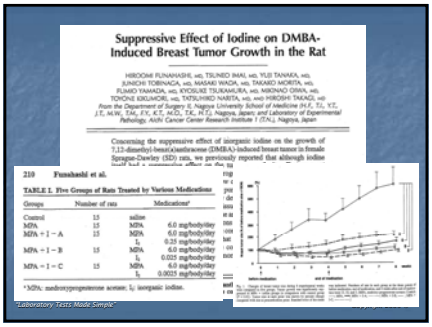
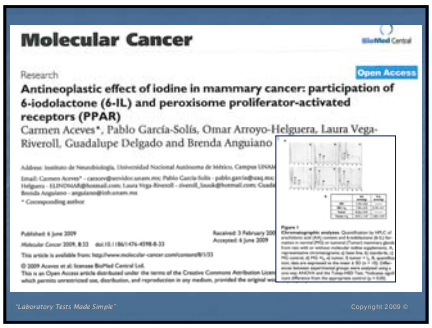
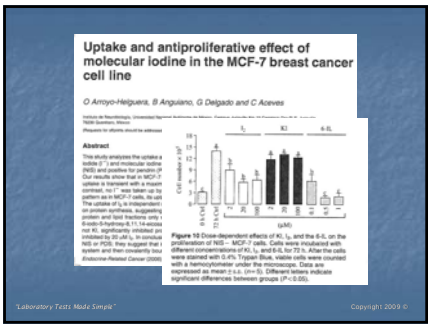
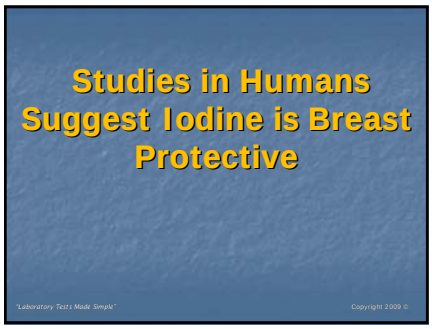
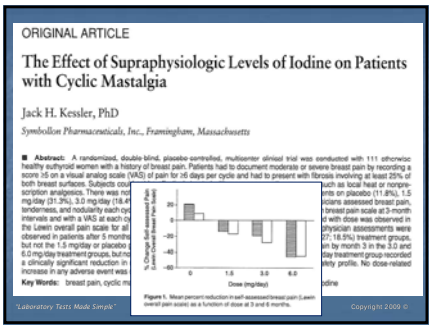


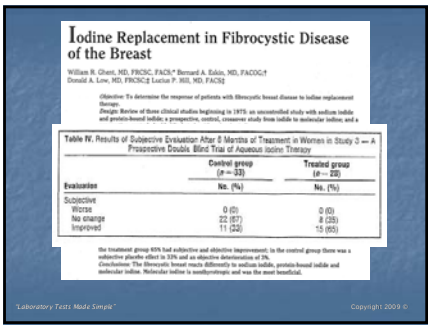


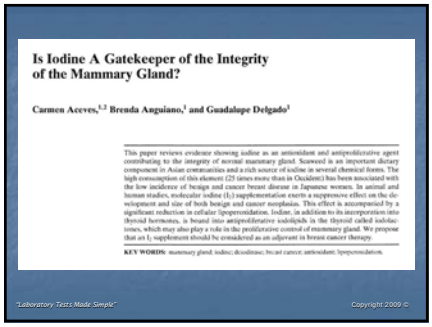


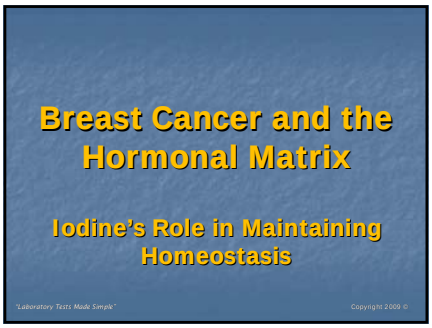


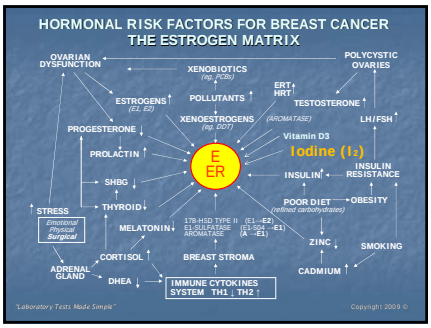


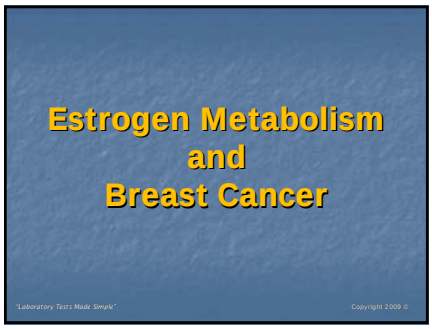


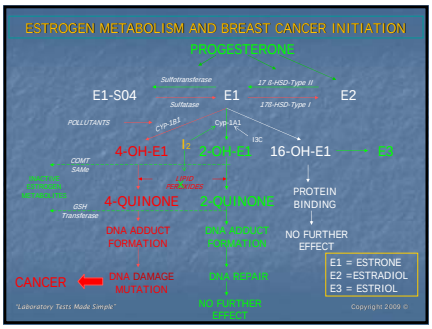


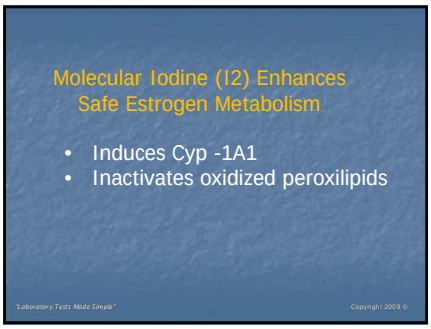








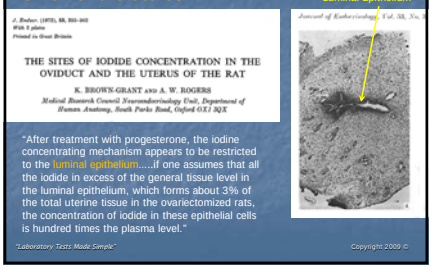




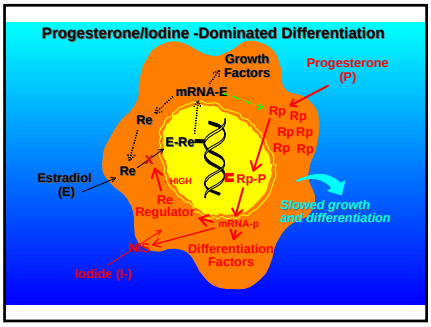
Progesterone / Iodine Synergy

Estrogen Metabolism and Breast Cancer

Progesterone increases iodine uptake in the lumen of the uterus



"After treatment with progesterone, the iodine concentrating mechanism appears to be restricted to the luminal epithelium....if one assumes that all the iodide in excess of the general tissue level in the luminal epithelium, which forms about 3% of the total uterine tissue in the ovariectomized rats, the concentration of iodide in these epithelial cells is hundred times the plasma level."



Iodine Deficiency

Breast Cancer Case History

Case History1-Breast Cancer

49 y/o premenopausal 195#, 5'5"
Hormone Therapy: Intermittent use of topical Pg (6 days since last used)

- Hot Flashes
- Night Sweats
- Memory Lapses
- Fatigue
- Stress
- Cold Intolerance
- Low Libido
- Mood Swings
- Nervous-Irritable
- Low Stamina
- Swelling/Puffy Eyes
- Nails Breaking/Brittle

Case History1-Breast Cancer

49 y/o premenopausal 195#, 5'5"
Hormone Therapy: None

Urinary Iodine Status:

Test	Test Results	Normal Range
Iodine (urine)	16 ug/L	100-1100 ug/L
Creatinine (urine)	0.45 mg/ml	0.3-3.5 m/ml
Iodine/Creatinine	36 ug/g Cr.	100-1000 ug/g

Iodine Status: Moderate-Severe Deficiency!

Case History 1-Breast Cancer

49 y/o premenopausal 195#, 5'5"

Summary

Pre/peri-menopausal patient suffering from a severe iodine deficiency, progesterone deficiency and estrogen dominance. Very recently diagnosed with infiltrating ductal carcinoma-grade III. Low iodine consistent with symptoms of estrogen dominance/progesterone deficiency and breast cancer.