Casual Friday Series

Functional Blood Chemistry Series
Pt. 17: Thyroid (I)

A Biogenetix Clinical Presentation

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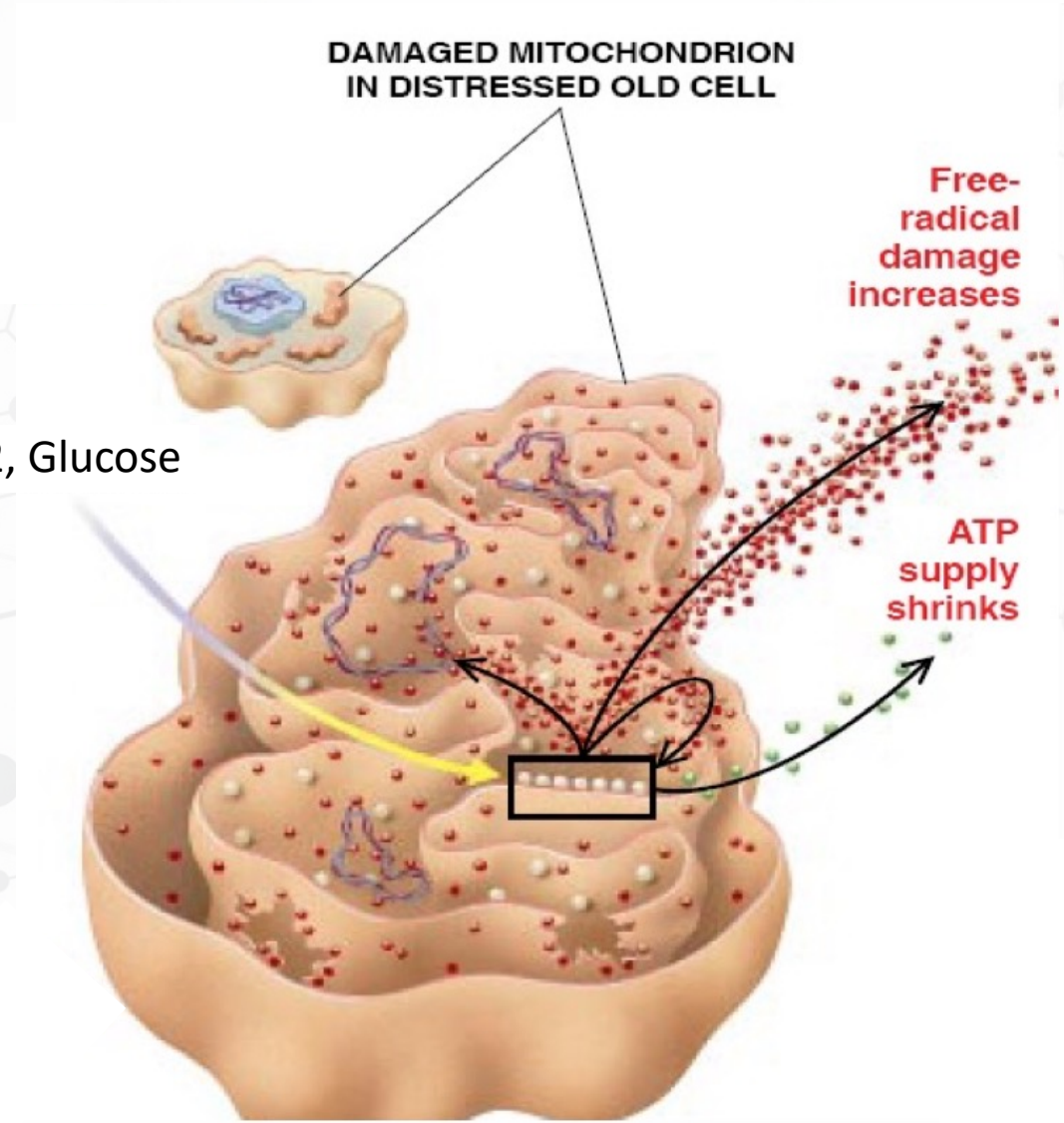
Disclaimer

- *Information in this presentation is not intended to diagnose, treat, reverse, cure, or prevent any disease. While this presentation is based on medical literature, findings, and text, The following statements have not been evaluated by the FDA.*
- *The information provided in this presentation is for your consideration only as a practicing health care provider. Ultimately you are responsible for exercising professional judgment in the care of your own patients.*

Thyroid


DAMAGED MITOCHONDRION
IN DISTRESSED OLD CELL
Free-
radical
damage
increases
ATP
supply
shrinks

O2, Glucose


ACU-RITE

Thyroid

- “Shield” gland
- Normally 6-20 gram in weight (non-goitrous)
  - Depends on body size and iodine supply
- Abundant blood supply with approximately 5ml/g/minute
  - Entire blood supply travels through the thyroid per hour
  - Even at only .4% of body weight, it receives approximately 2% of blood flow

Thyroid Hormone Function

- Basal metabolic rate
  - Thermogenesis (calorigenesis), or O2 consumption and energy production
  - Encourages synthesis of certain enzymes within the CAC
- Essential to normal growth, development and metabolism

Thyroid

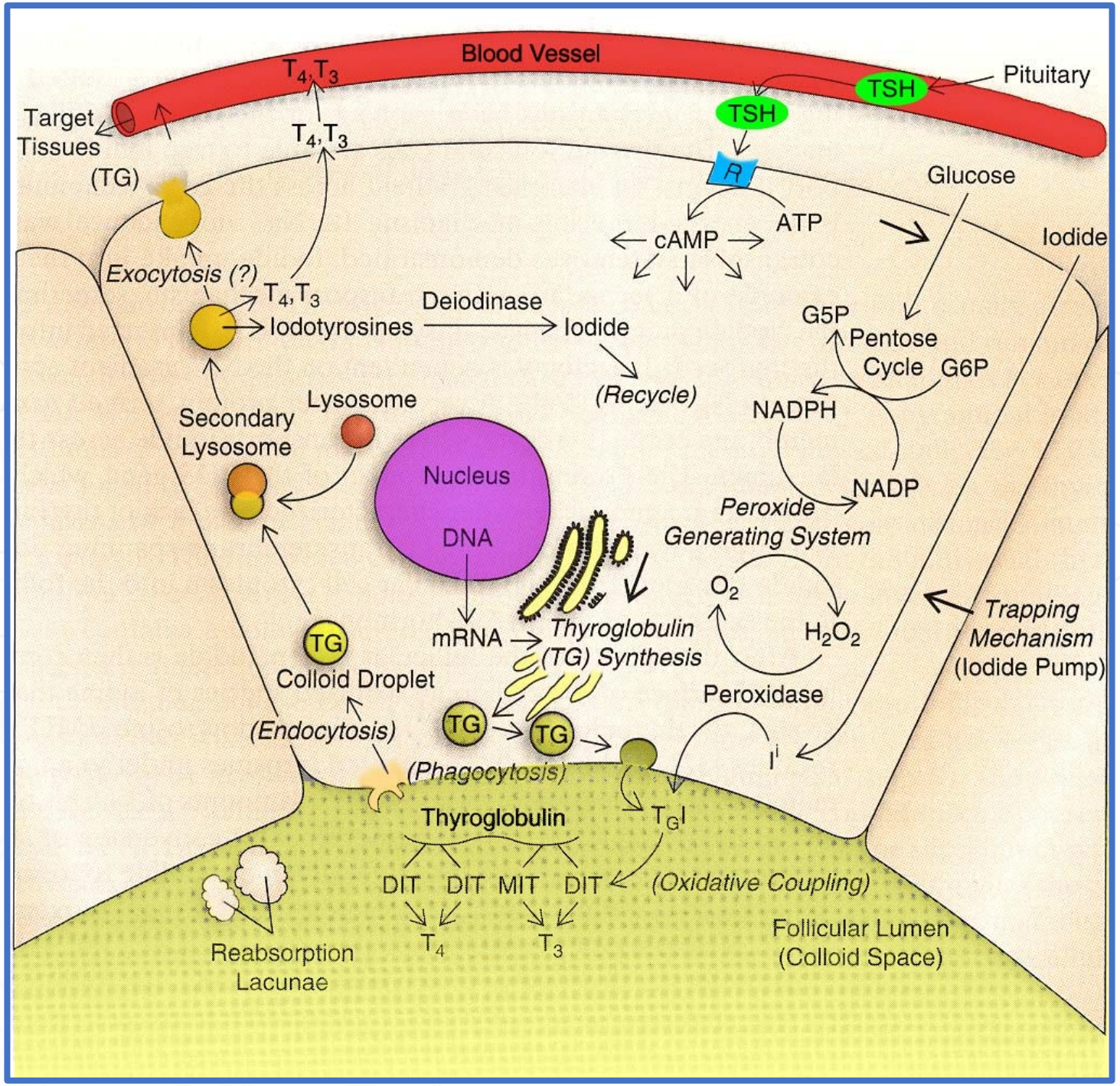
- Consists of *follicles* and “C cells”
  - C cells are responsible for calcitonin production, which aids in lowering plasma calcium levels when elevated
- Follicles
  - Simple cuboidal cells (thyrocytes) surrounding colloid (“glue like”)
  - Primary secretory cells of the thyroid gland
  - Colloid is largely a mixture of proteins suspended in a gelatinous solution
  - Free fatty acids are the primary fuel source for follicular cells
  - Does use glucose for the pentose phosphate pathway
    - Needs reducing agents (NADPH) for H2O2, glutathione peroxidase, thyroid hormone synthesis, organification of iodide, etc

Thyroid Hormone Synthesis

- Iodine trapping
  - Dietary iodine is converted to iodide in intestines
  - Iodide (anion) is transported into follicular cells via Na/I symport (co-transport). This is increased under influence of TSH
- Thyroglobulin
  - Large polypeptide (5,000 amino acids) with 3% tyrosine
  - Synthesized on ribosomes in response to TSH
- Thyroid peroxidase oxidizes iodide (oxidation) and attaches iodine to tyrosine residues on thyroglobulin (iodination)
  - Uses H2O2 to oxidize iodine
  - Forms MIT (one iodine) and DIT (two iodines)

Thyroid Hormone Synthesis

- MIT and DIT still on thyroglobulin, return back into follicular cell via endocytosis
- MIT and DIT are joined together
  - MIT + DIT = T3 (triiodothyronine)
  - DIT + DIT = T4 (tetraiodothyronine or thyroxine)
- Lysosome (proteolytic enzymes) cleaves off free T3 and T4, which leaves follicular cell via exocytosis
- Free thyroid hormone is bound primarily to plasma proteins for transport in the circulatory system


Blood Vessel
T_4, T_3
Pituitary
TSH
TSH
Target Tissues
T_4, T_3
R
Glucose
(TG)
ATP
cAMP
Iodide
Exocytosis (?)
T_4, T_3
Deiodinase
Iodotyrosines
Iodide
G5P
Pentose Cycle
G6P
(Recycle)
NADPH
Secondary Lysosome
Lysosome
Nucleus
DNA
NADP
Peroxide Generating System
O_2
H_2O_2
Trapping Mechanism (Iodide Pump)
mRNA
Thyroglobulin (TG) Synthesis
TG
Colloid Droplet
Peroxidase
(Endocytosis)
TG
TG
I^i
(Phagocytosis)
Thyroglobulin
T_GI
DIT DIT MIT DIT
(Oxidative Coupling)
T_4
T_3
Reabsorption Lacunae
Follicular Lumen (Colloid Space)

Thyroid Hormone Transport

Functions

- Protect body from excessive hormone fluctuations
  - For example: Bound thyroid hormone allows a significant drop in hormone secretion without significantly impacting serum hormone levels
- Iodine binding to minimize loss in humans
  - Limited iodine supply in diet
- Targeting hormone delivery via site specific enzymatic modification of thyroid binding globulin

Thyroid hormone transport

- Thyroid Binding Globulin (highest affinity)
  - 5-day half-life
  - 75% of T4 and 75% of T3
  - Salicylates competitively bind
  - Estrogen increases levels, androgens (eg testosterone) decrease levels
- Transthyretin
  - 2-day half-life
  - 20% of T4 and <5% of T3
  - Flavonoids may competitively bind
- Albumin (lowest affinity)
  - 15-day half-life
  - 5% of T4 and 20% of T3
  - Fatty acids and chloride ions may competitively bind
  - Fluctuations are said to have little effect on serum thyroid hormone levels

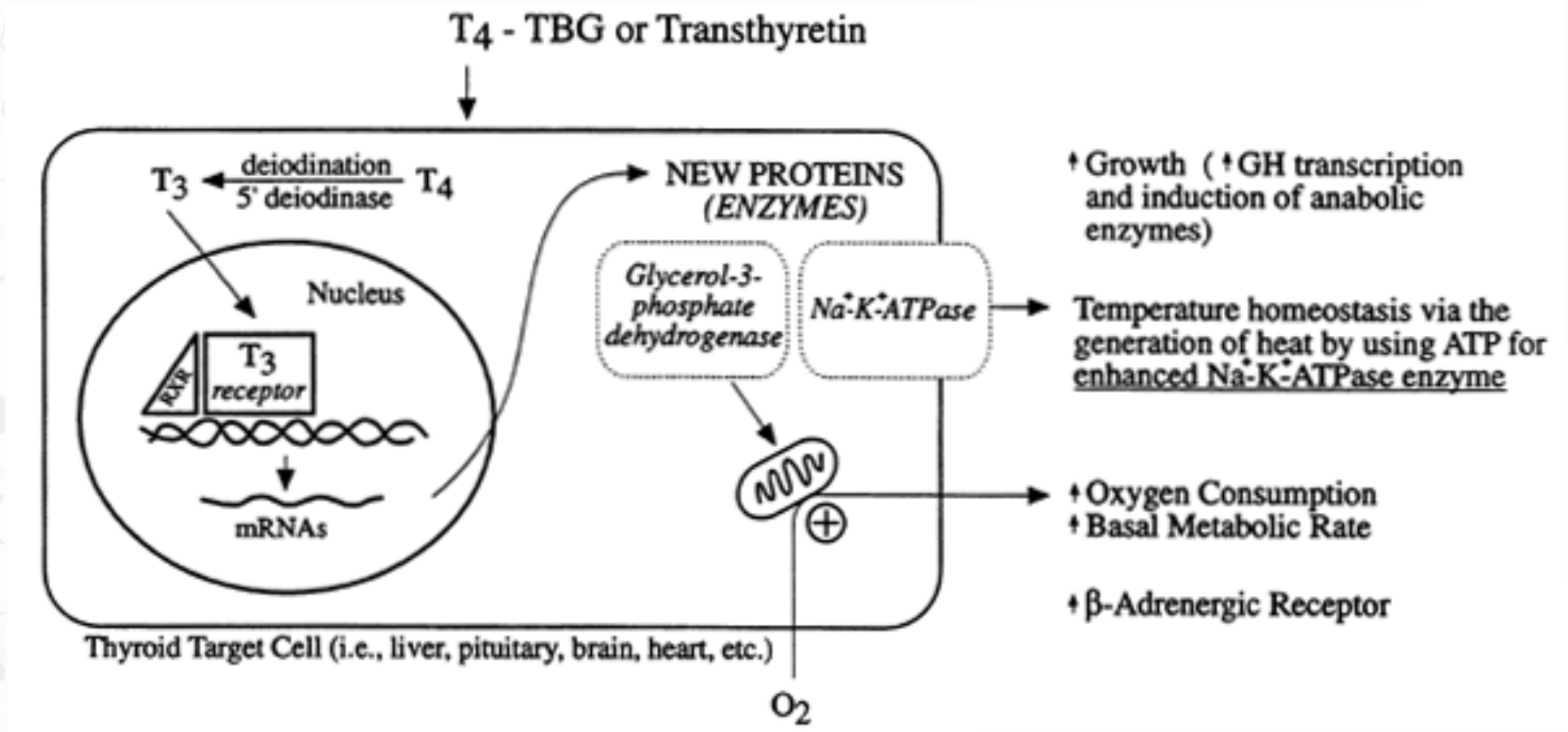
Thyroid Hormone Transport

In humans, .03% of T4 and .3% of T3 are found in the free (unbound) form.

Thyroid Hormone Conversion

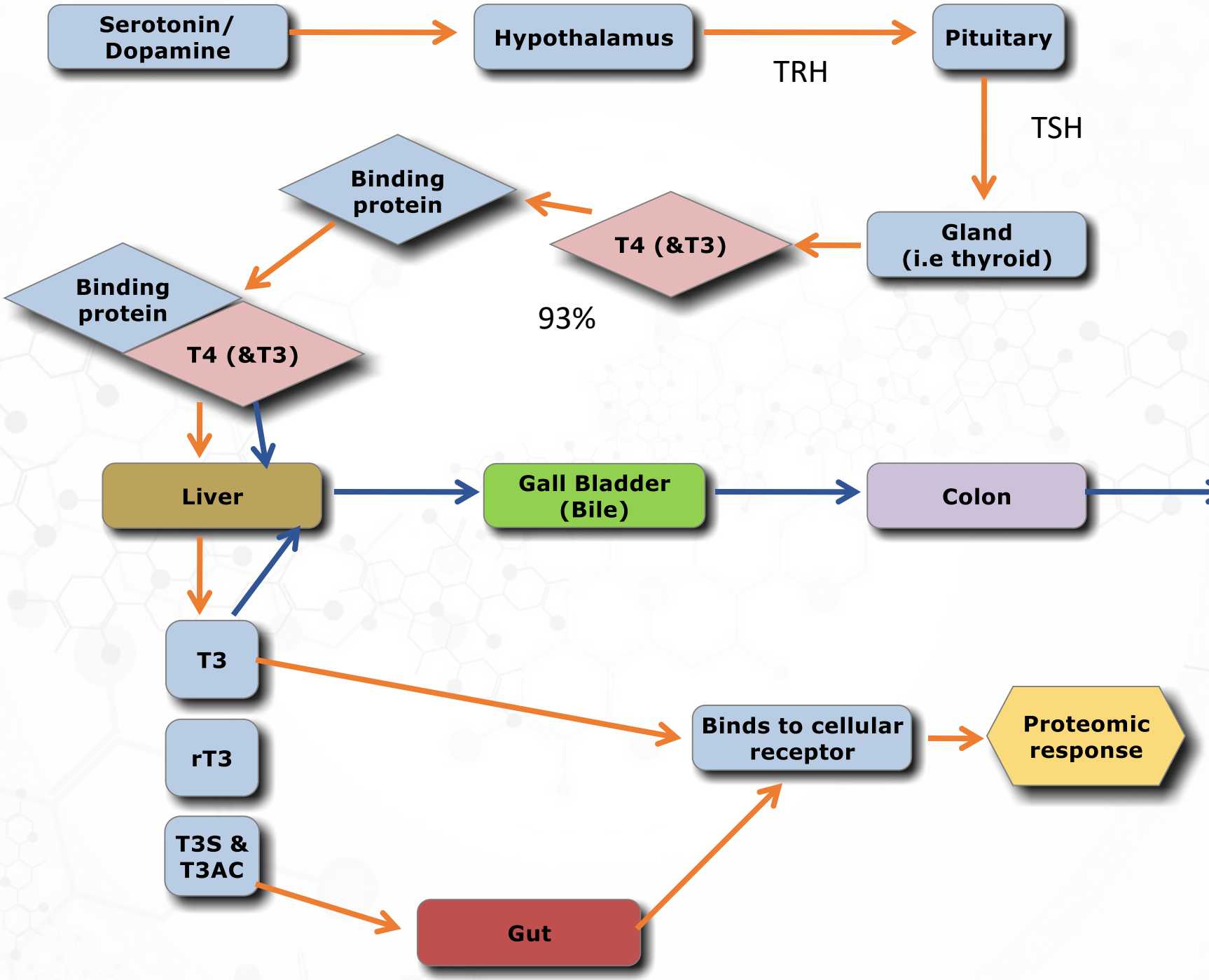
- Approximately 1/3 of T4 is converted to T3, 1/3 is converted to rT3 and the remainder is metabolized in different pathways.
- Deiodinases
  - D1 – liver, kidney, muscle and thyroid
    - Also used in the degradation of thyroid hormone
  - D2 – CNS, pituitary, gonads and brown adipose tissue
    - Maintains local T3 levels, but not plasma levels
  - D3 – brain
    - Degradation activities

Thyroid Hormone Mechanism



Low Thyroid Symptoms

- Cold extremities
- Difficulty losing weight
- Depression; slow mental function
- Dry skin, hair and brittle nails
- Hair loss
- Constipation
- Poor/slow wound healing


Serotonin/ Dopamine
Hypothalamus
TRH
Pituitary
TSH
Gland (i.e thyroid)
T4 (&T3)
Binding protein
93%
Binding protein
T4 (&T3)
Liver
Gall Bladder (Bile)
Colon
T3
rT3
T3S & T3AC
Gut
Binds to cellular receptor
Proteomic response

Thyroid Markers

TSH	• 1.5-2.0
Total Thyroxine (TT4)	• 6.0-12.0
Free Thyroxine (FT4)	• 1.0-1.5
Free Thyroxine Index (FTI)	• Less accurate (calculation)
Resin T3 Uptake (T3U)	• 28-38% (Men: 32-38; Women: 28-34)
Total Triiodothyronine (TT3)	• 100-180
Free Triidothyroinine (FT3)	• 3.0-4.0
Reverse T3 (rT3)	• Lab range
Thyroid Antibodies (TGB, TPO)	• If positive, likely Hashimoto's

Low TSH and Low T4

- Could be poor hypothalamic function
  - Serotonin, dopamine, heavy metals, inflammation
- Could be pituitary suppression
  - Cortisol, inflammation, dysbiosis (lipopolysaccharides), heavy metals

High TSH, Low T4

- Autoimmune (Hashimoto's)
  - Run thyroid antibodies
    - Anti-thyroglobulin antibodies
    - Thyroid peroxidase antibodies
- Iodine deficiency
  - Iodine intake
  - Goitrogen
    - Fluoride, bromide
    - Arsenic
    - Brassica family (cabbage, broccoli, kale, etc)
- Tyrosine deficiency
  - Not likely. Must be a fairly significant amino acid deficiency to cause this.

Low T3 Uptake, Normal T4/T3, Low free T4/T3

- Likely excess thyroid binding globulin
  - Elevated estrogen is most common reason for excess thyroid binding globulin

High T3 Uptake, Normal T4/T3, high free T4/T3

- Likely due to elevated testosterone
  - In women, consider blood sugar dysregulation and Polycystic Ovary Syndrome
  - High correlation between Hashimoto's and PCOS

Normal T4, Low T3

- Underconversion of T4 to T3
  - May also be overconverting to rT3
  - Selenium deficiency
  - Inflammation, cortisol, heavy metals, arsenic

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Chemicals and the Thyroid

- Iodine uptake – phthalates, perchlorate
- Thyroid enzymes – pesticides and fungicides
- Deactivating thyroid hormones – lead, chromium, methoxychlor (pesticide)
- PBDEs – inhibit thyroid hormone binding to transthyretin
- PCBs – binds to thyroid binding globulin
- Pentachlorophenol – inhibits thyroid hormone production
- Cadmium, lead, methyl-mercury, Bisphenol A, dioxin, pesticides
- Isoflavones, catechin?

Impacts on TSH

STIMULATORY

Thyrotropin-releasing hormone (TRH)

Prostaglandins (?)

α -adrenergic agonists (? Via TRH)

Opioids (humans)

Vasopressin (AVP) (long term)

Glucagon-like peptide 1 (GLP-1)

Leptin

Glucocorticoids (in vitro)

INHIBITORY

Thyroid hormones and analogues

Dopamine

Gastrin

Opioids (rat)

Glucocorticoids (in vivo)

Serotonin

Cholecystokinin (CCK)

Gastrin-releasing peptide (GRP)

Vasopressin (AVP) (short-term)

Neuropeptide Y (NPY)

Interleukin 1 β and 6

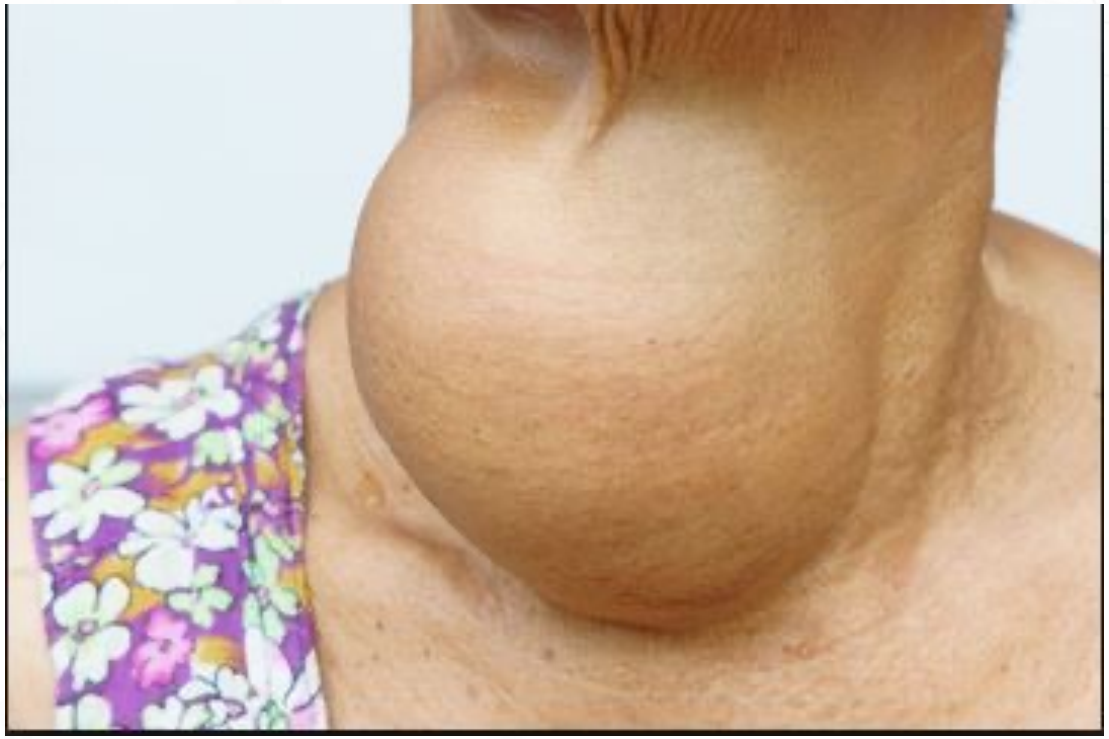
Tumor necrosis factor α

Thyroid Interactions

Interactions with other hormones

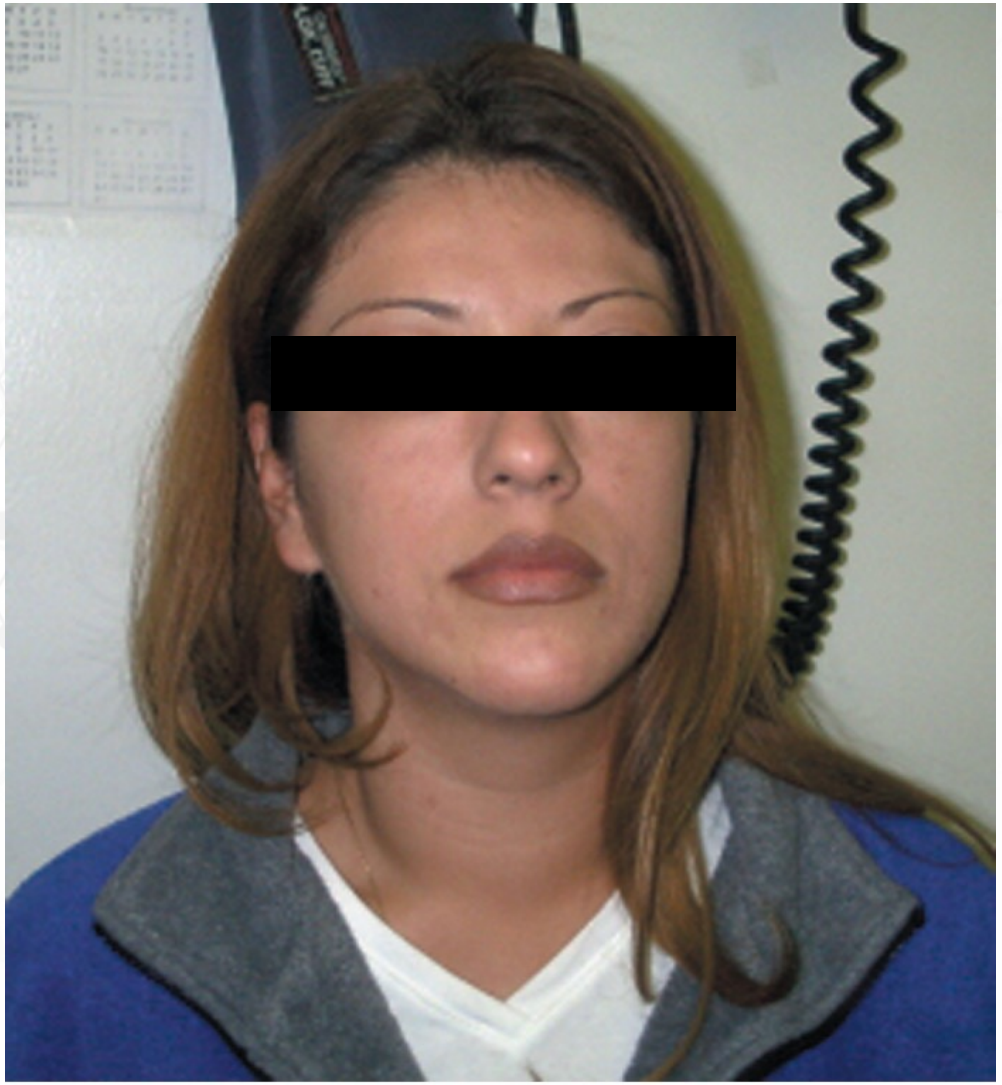
- Cortisol
  - Increased – decreases TSH and TBG (high dose), decreases T4/T3 ratio (increases T4/rT3 ratio)
  - Decreased – increased TSH
  - Increases in thyroid hormone, increase cortisol clearance in liver, and thus leads to more ACTH production
- Estrogen
  - Increased TBG, TSH (postmenopausal women), increased T4 requirement in hypothyroid patients
- Testosterone
  - Decreased TBG, decreased T4 turnover in women, reduced T4 requirement in hypothyroid patients
- Growth hormone
  - Decreased D3 activity

Goiter



Goiter

Goiter



Source: Usatine RP, Smith MA, Mayeaux EJ, Chumley HS: *The Color Atlas of Family Medicine, Second Edition:* www.accessmedicine.com

Goiter

- A goiter can occur in a gland that is producing too much hormone (hyperthyroidism), too little hormone (hypothyroidism), or the correct amount of hormone (euthyroidism). A goiter indicates there is a condition present which is causing the thyroid to grow abnormally.

https://www.thyroid.org/goiter/

Goiter

- Hashimoto's thyroiditis is a more common cause of goiter formation in the US. This is an autoimmune condition in which there is destruction of the thyroid gland by one's own immune system. As the gland becomes more damaged, it is less able to make adequate supplies of thyroid hormone. The pituitary gland senses a low thyroid hormone level and secretes more TSH to stimulate the thyroid. This stimulation causes the thyroid to grow, which may produce a goiter.

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Goiter

- Another common cause of goiter is Graves' disease. In this case, one's immune system produces a protein, called thyroid stimulating immunoglobulin (TSI). As with TSH, TSI stimulates the thyroid gland to enlarge producing a goiter. However, TSI also stimulates the thyroid to make too much thyroid hormone (causes hyperthyroidism). Since the pituitary senses too much thyroid hormone, it stops secreting TSH. In spite of this the thyroid gland continues to grow and make thyroid hormone. Therefore, Graves' disease produces a goiter and hyperthyroidism.

https://www.thyroid.org/goiter/

Goiter

- Multinodular goiters are another common cause of goiters. Individuals with this disorder have one or more nodules within the gland which cause thyroid enlargement. This is often detected as a nodular feeling gland on physical exam. Patients can present with a single large nodule or with multiple smaller nodules in the gland when first detected.

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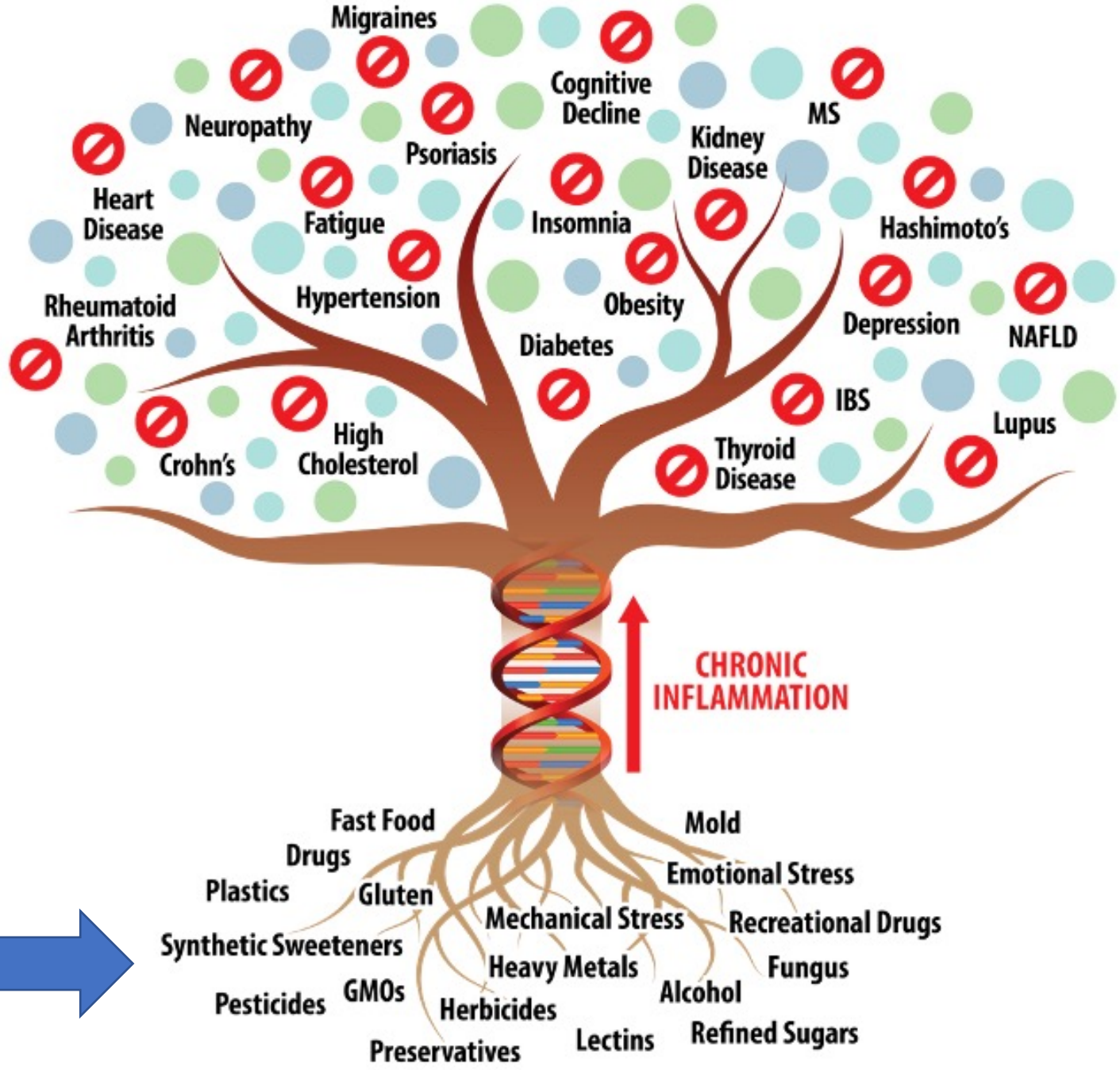
Migraines
Neuropathy
Psoriasis
Cognitive Decline
MS
Kidney Disease
Heart Disease
Fatigue
Insomnia
Hashimoto's
Hypertension
Obesity
Depression
NAFLD
Rheumatoid Arthritis
Diabetes
IBS
Lupus
Crohn's
High Cholesterol
Thyroid Disease
CHRONIC INFLAMMATION
Fast Food
Mold
Drugs
Emotional Stress
Plastics
Gluten
Mechanical Stress
Recreational Drugs
Synthetic Sweeteners
Heavy Metals
Fungus
Pesticides
GMOs
Alcohol
Herbicides
Refined Sugars
Lectins
Preservatives

The Wedge Protocol