Thyroid: Function, Dysfunction, and Emergencies

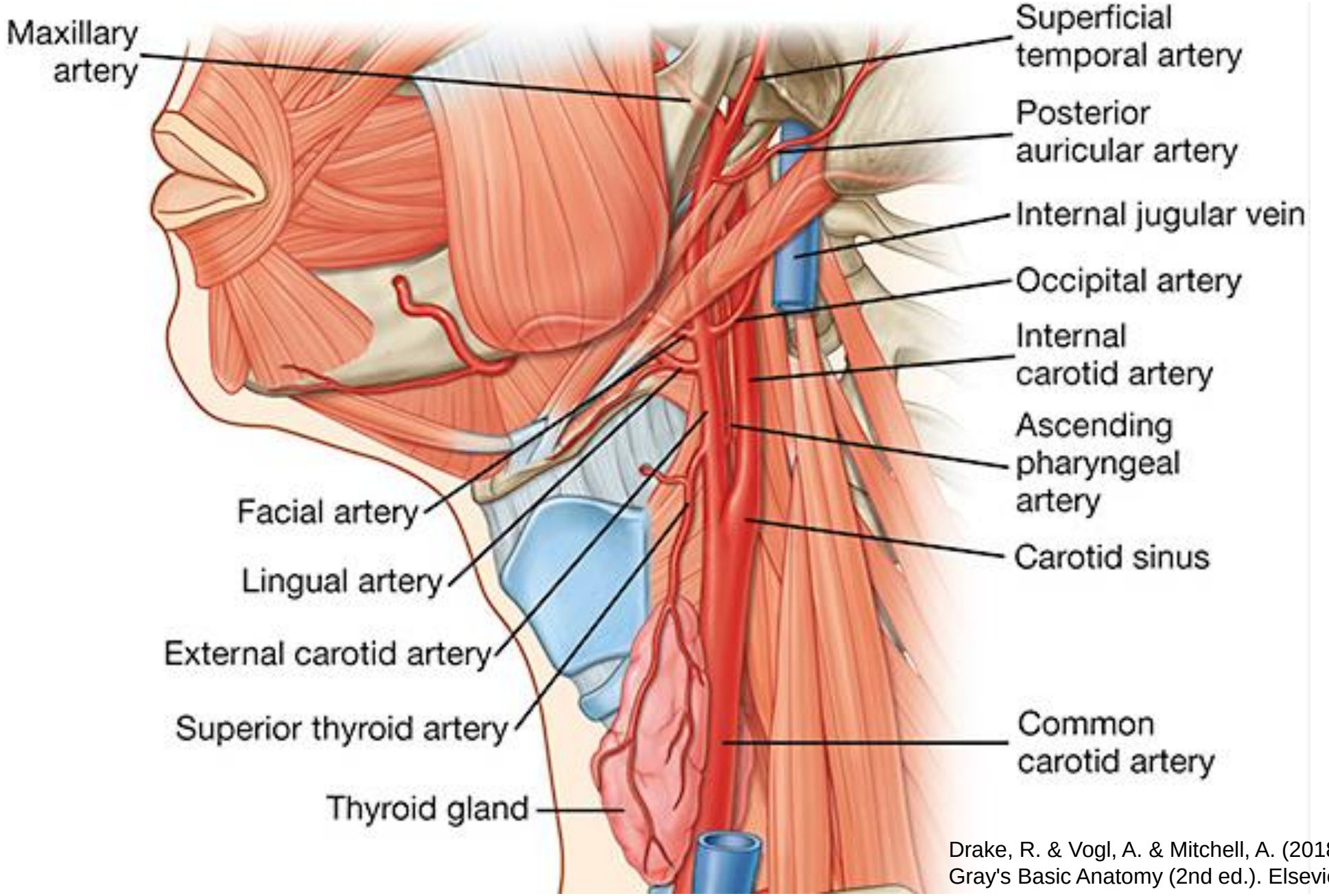
Adrian Araya MD

Conflict of interest

- I do not have any financial disclosures
- Images are for educational purposes only

Objectives

- Understand thyroid hormone synthesis
- Differentiate primary hypothyroidism and hyperthyroidism
- Relate thyroid ab testing to disease
- Understand thyroid function in obesity
- Thyroid emergencies



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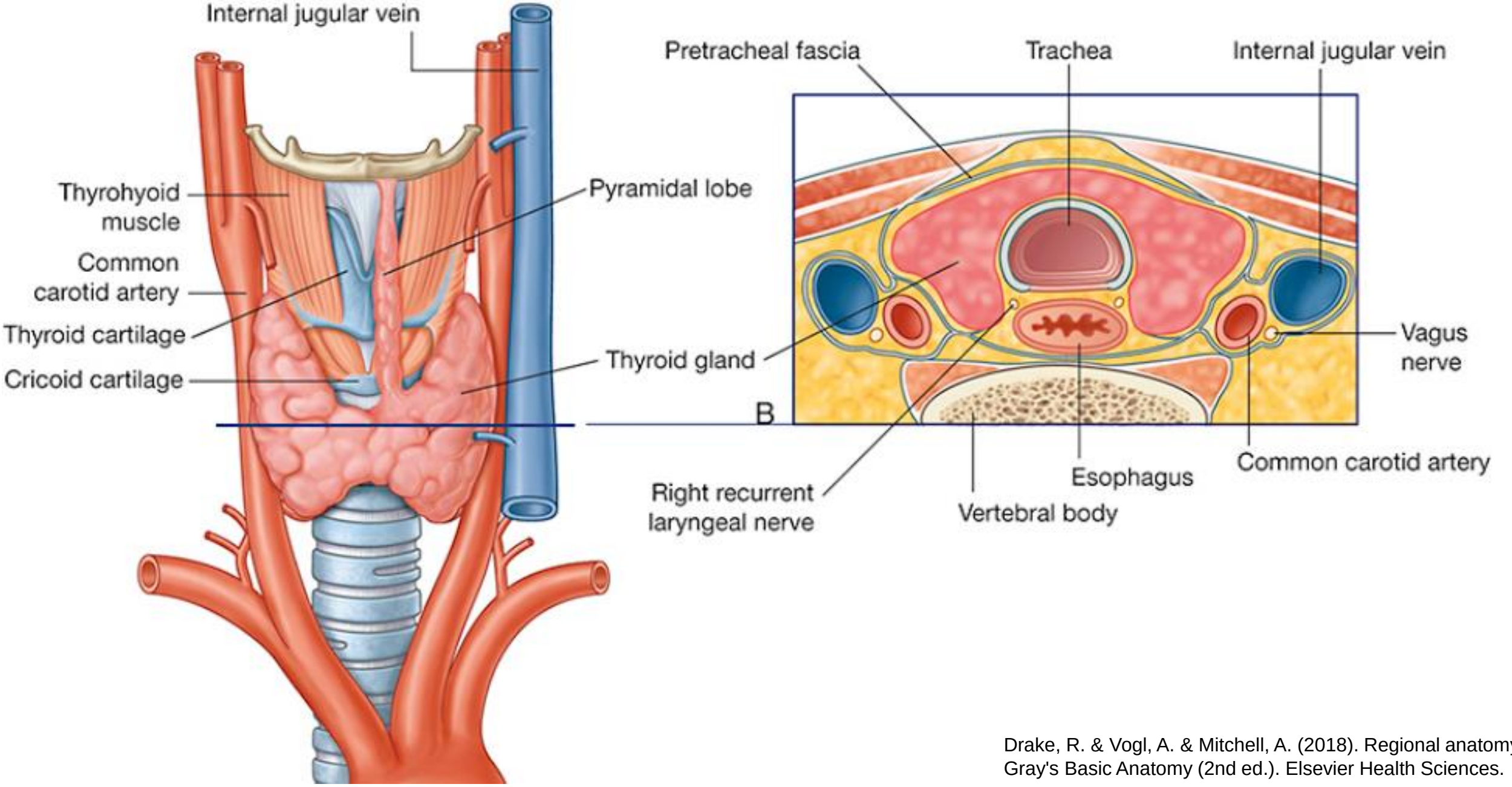

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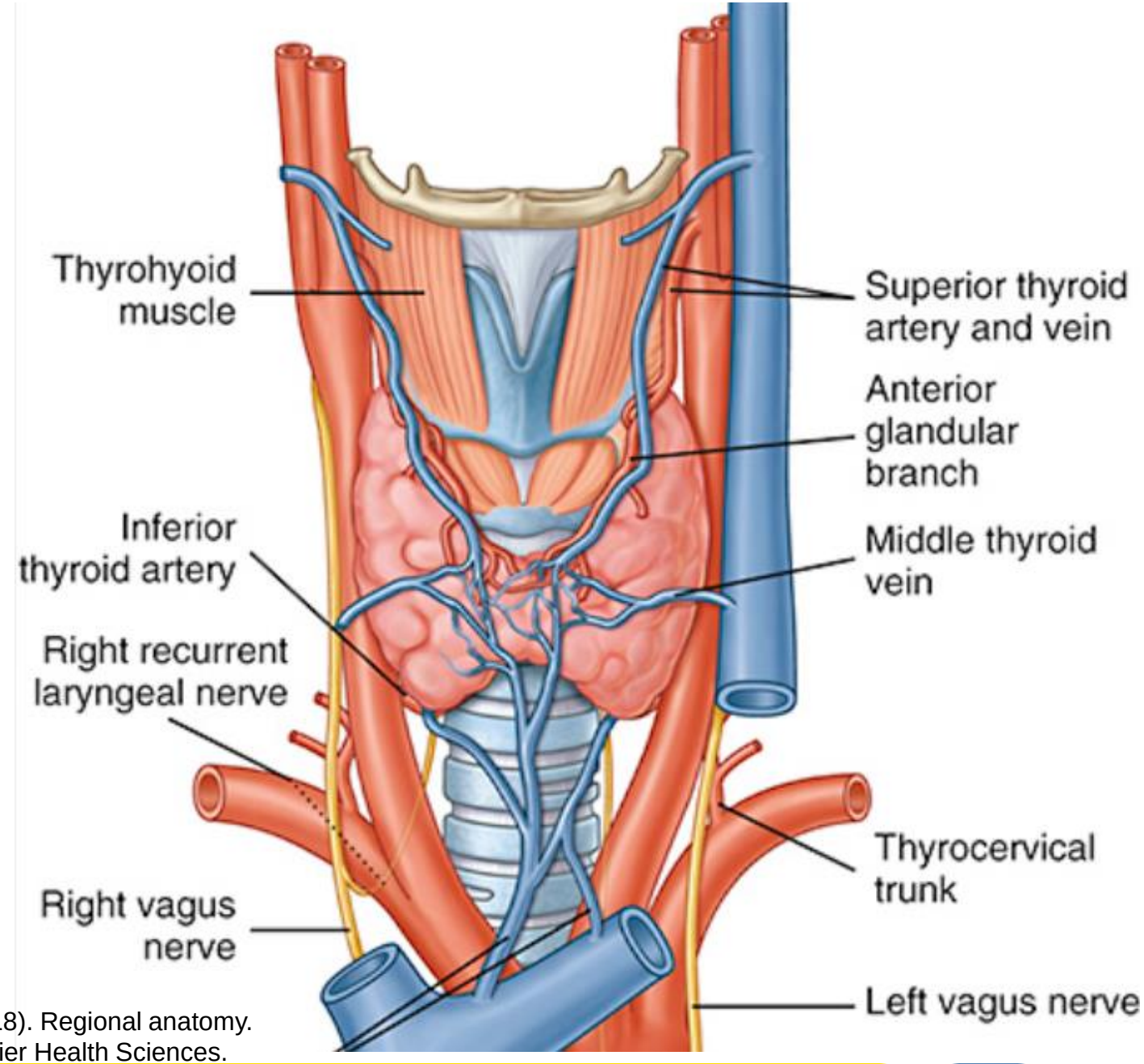

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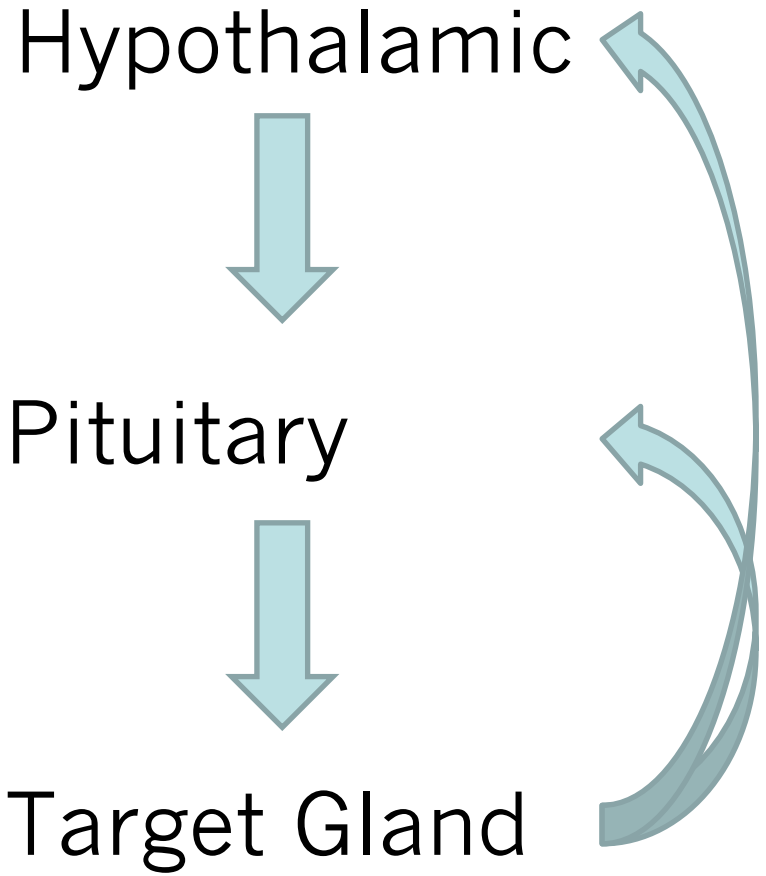
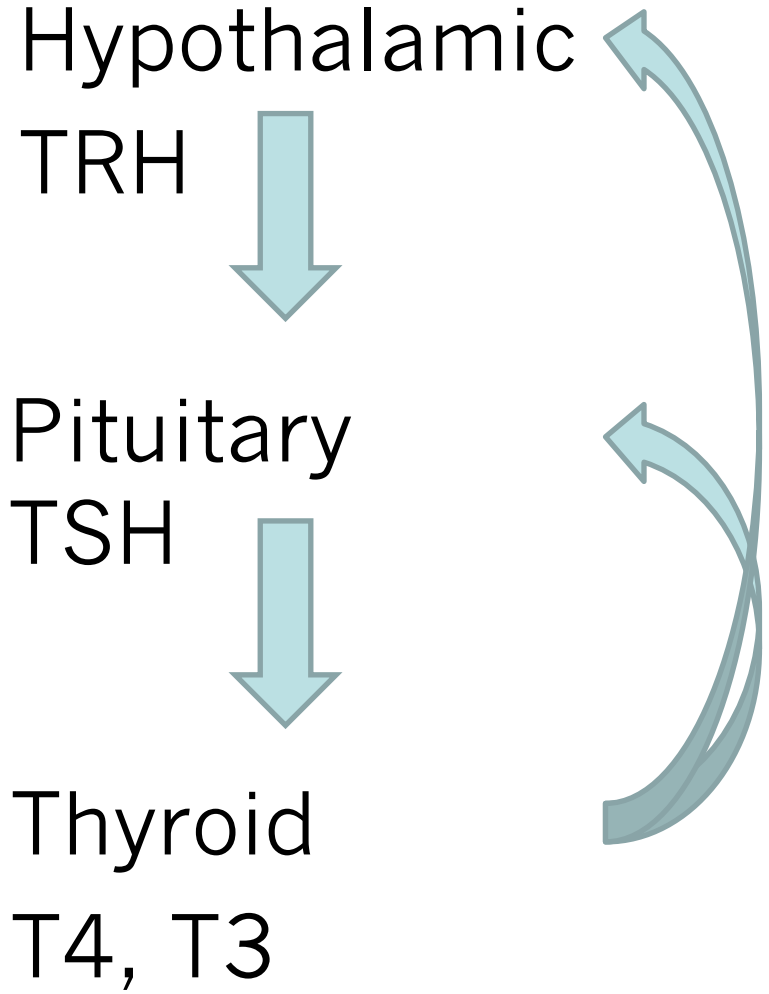
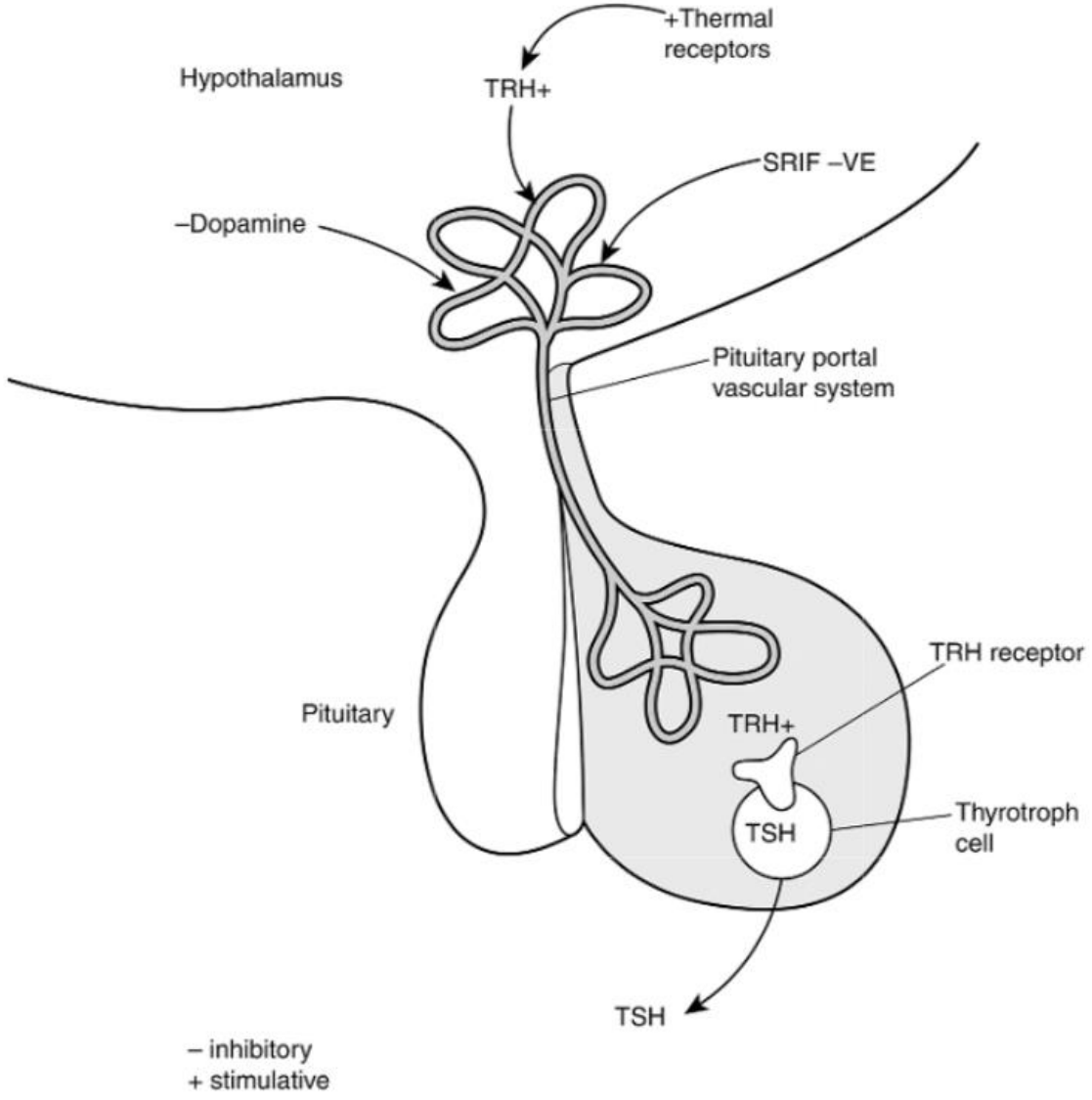
Thyroid Hormone Synthesis





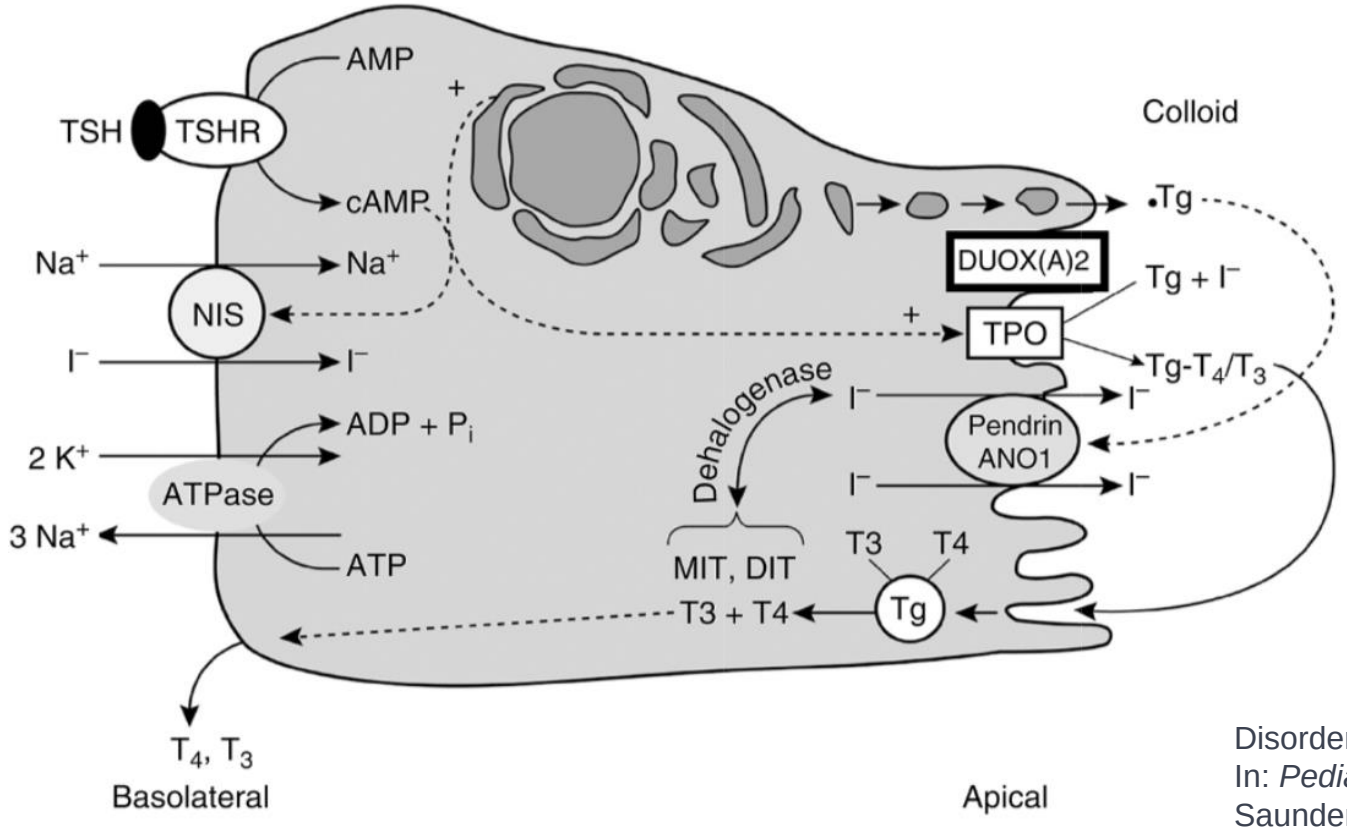


Thyroid disorders in childhood and adolescence.
In: *Pediatric Endocrinology*, M. Sperling, ed. 3rd ed.,
Saunders, Philadelphia, pp. 227–253

https://bcrc.bio.umass.edu/courses/spring2018/biol/biol523/content/thyroid-20x-0

Hypothalamic-pituitary-thyroidal axis

Thyroid follicular cells



Disorders of the thyroid in the newborn and infant. In: *Pediatric Endocrinology*, M. Sperling, ed. 3rd ed. Saunders, Philadelphia

Thyroid Hormone Synthesis

- Thyrotropin releasing hormone (TRH)
  - Hypothalamic peptide hormone which acts on anterior pituitary thyrotrophs
- Thyroid stimulating hormone (TSH)
  - Anterior pituitary derived glycoprotein that targets thyroid follicular cells

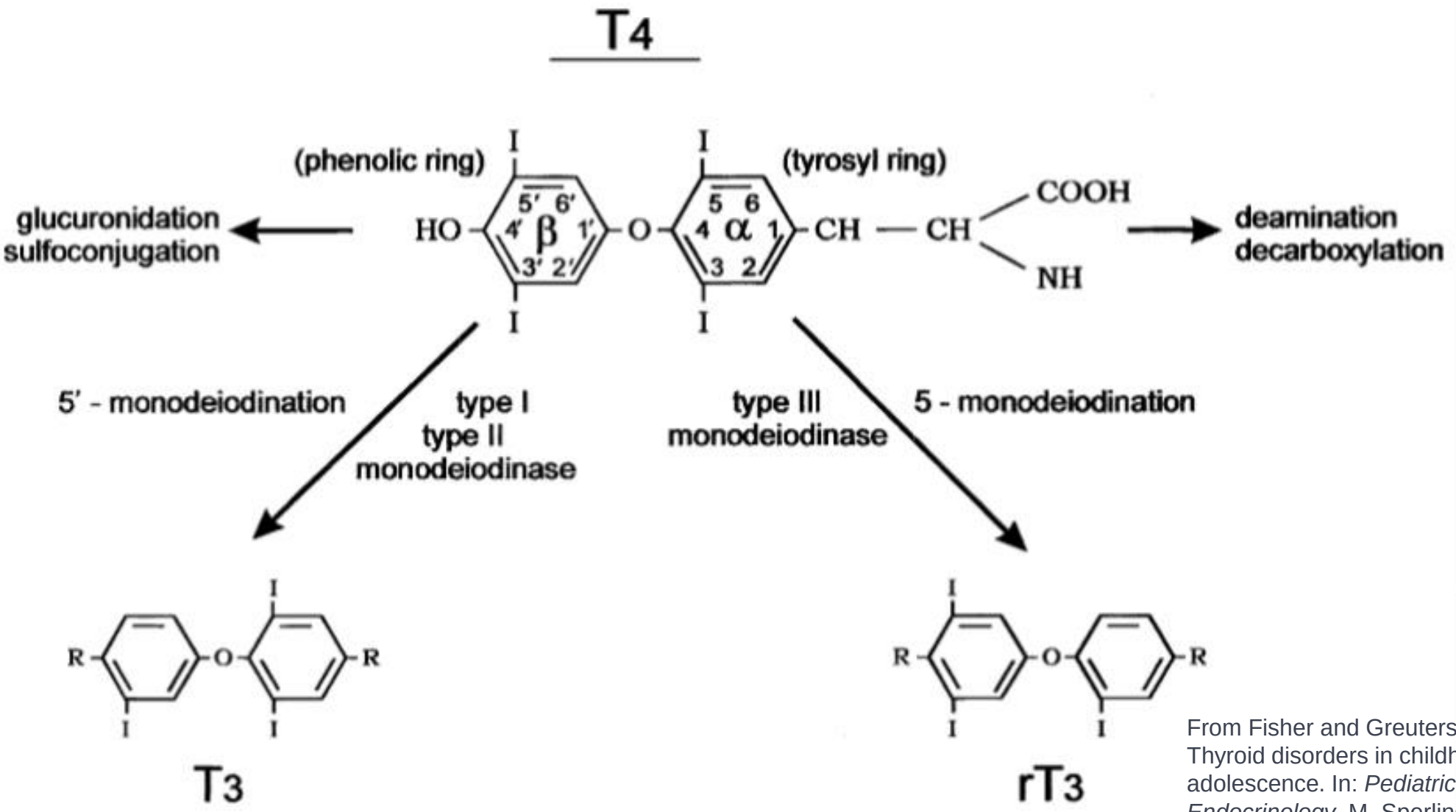
- TSH structure
  - Shares common alpha subunit with other hormones: LH, FSH, HCG
  - Beta subunit imparts specificity of function
  - Overwhelming amounts of TSH can stimulate those other receptors

Thyroid hormone

- Thyroxine
  - ~97% of released thyroid hormone
  - < 1% remains free in circulation
    - Bound by thyroglobulin, prealbumin, and albumin
    - Measurement of free T4 bypasses abnormal labs caused by carrier protein dysfunction

Thyroid hormone

- Triiodothyronine
  - Also released by follicular cell
  - Primarily generated peripherally by deiodination of thyroxine
  - greater affinity for thyroid hormone receptor



From Fisher and Greuters [2008] Thyroid disorders in childhood and adolescence. In: *Pediatric Endocrinology*, M. Sperling, ed. 3rd ed., Saunders, Philadelphia, pp. 227–253.

Labs

Lab	Indication	Cost
TSH	Hypo & Hyper	$84
FT4	Hypo & Hyper	$174
Total T3	Hyper	$21.75
Anti-thyroperoxidase	Hypo & Hyper	$276-310
Thyroid Stimulating Ig	Hyper	$ 353
Thyroid US	Palpable nodule or asymmetry	
Thyroid uptake	Hyper	
Total T4, FT3, resin uptake	Do not order	

RESEARCH ARTICLE

Low Value of Thyroid Testing in the Pediatric Inpatient Setting

Ahmed Torky, MD,[a] Meredith LaRue, CFNP,[b] Paul Kaplowitz, MD, PhD[b]

ABSTRACT

OBJECTIVES: Our objective was to assess the frequency of pediatric inpatient thyroid testing, frequency of detection of abnormal results, and apparent impact on patient management.

METHODS: This is a retrospective study of admissions from July 2015 to June 2016 at a large urban children's hospital. Chart review was conducted on all hospitalized pediatric patients who underwent thyroid testing. We used a normal range of 0.5 to 5.0 μIU/mL for thyroid-stimulating hormone (TSH) and 1.0 to 2.0 ng/dL for free thyroxine (FT4), except for neonates for whom we used the higher reference ranges specified by the hospital laboratory.

RESULTS: Thyroid testing occurred in 1202 (5.7%) of 20 907 hospitalizations; 79.3% had combined thyroid function tests (TFTs) with TSH + FT4 being most common, and 20.6% had TSH only. Combined TFTs were ordered routinely by psychiatry and frequently by endocrine, gastrointestinal, cardiology, and neurology services, but many cases had no identified reason for testing. Of the 205 abnormal tests (17.1%), the most common abnormalities in the combined TFTs group were normal FT4 and increased TSH (35.4%) (76% of which were between 5 and 10 μIU/mL), normal FT4 and TSH 0.1 to 0.5 μIU/mL (33.1%), and high FT4 but normal TSH (14.3%). Patients with new-onset type 1 diabetes had borderline low or high TSH in about 20% of cases, but all abnormalities resolved at outpatient follow-up. Overall, 8 patients (0.66%) were started on levothyroxine.

CONCLUSIONS: Pediatric inpatient thyroid testing is relatively common at our institution, and although results are often abnormal, they do not point to thyroid disease that has contributed to the reason for hospitalization and do not identify patients in urgent need of starting therapy.

Functional Understanding

- Primary: indicates disease process happening at end target organ
  - Primary adrenal insufficiency: adrenal disease
  - Secondary adrenal insufficiency: Pituitary disease

- Hypothyroidism and Hyperthyroidism: systemic thyroid hormone concentration dysfunction

↑ TSH, ↓ FT4	Primary Hypothyroidism
↓ TSH, ↑ FT4	Primary Hyperthyroidism
↓ TSH, ↓ FT4	Secondary Hypothyroidism
↑ TSH, ↑ FT4	Secondary Hyperthyroidism (rare)

Case

- A 13-year-old male presents to your office after talking with his therapist for depression. Family is concerned that he hasn't been as engaged with school and feels tired despite normal sleep schedule. ROS + for dry skin, constipation
- ROS – for fever or pain
- Depression?
  - Prevalence 3.2% in 2019 in ages 3-17

Ghandour RM, Sherman LJ, Vladutiu CJ, Ali MM, Lynch SE, Bitsko RH, Blumberg SJ. Prevalence and treatment of depression, anxiety, and conduct problems in U.S. children. *The Journal of Pediatrics*, 2019;206:256-267

Hypothyroidism

- Signs and symptoms:
  - Cold intolerance, fatigue, constipation, dry skin, brittle and coarse hair, bradycardia, carotenemia, and myxedema
- DDx:
  - Hashimoto thyroiditis, infection, de Quervain (brief hypothyroid phase), radiation therapy, trauma, cystinosis

Sperling, M. *Pediatric Endocrinology*. Philadelphia, PA: Saunders/Elsevier, 2020

Hypothyroidism: Hashimoto

- Most common:
  - Prevalence 3% in pediatric age; F > M
  - Uncommon under 3 years of age
- Ab: positive for thyroglobulin and/or thyroperoxidase
- Pathophysiology:
  - Lymphocytic infiltration of thyroid gland resulting in destruction of thyroid architecture.
- Exam:
  - Goiter v silent

Alejandro Diaz, Elizabeth G. Lipman Diaz; Hypothyroidism. *Pediatr Rev* August 2014; 35 (8): 336–349. https://doi.org/10.1542/pir.35.8.336

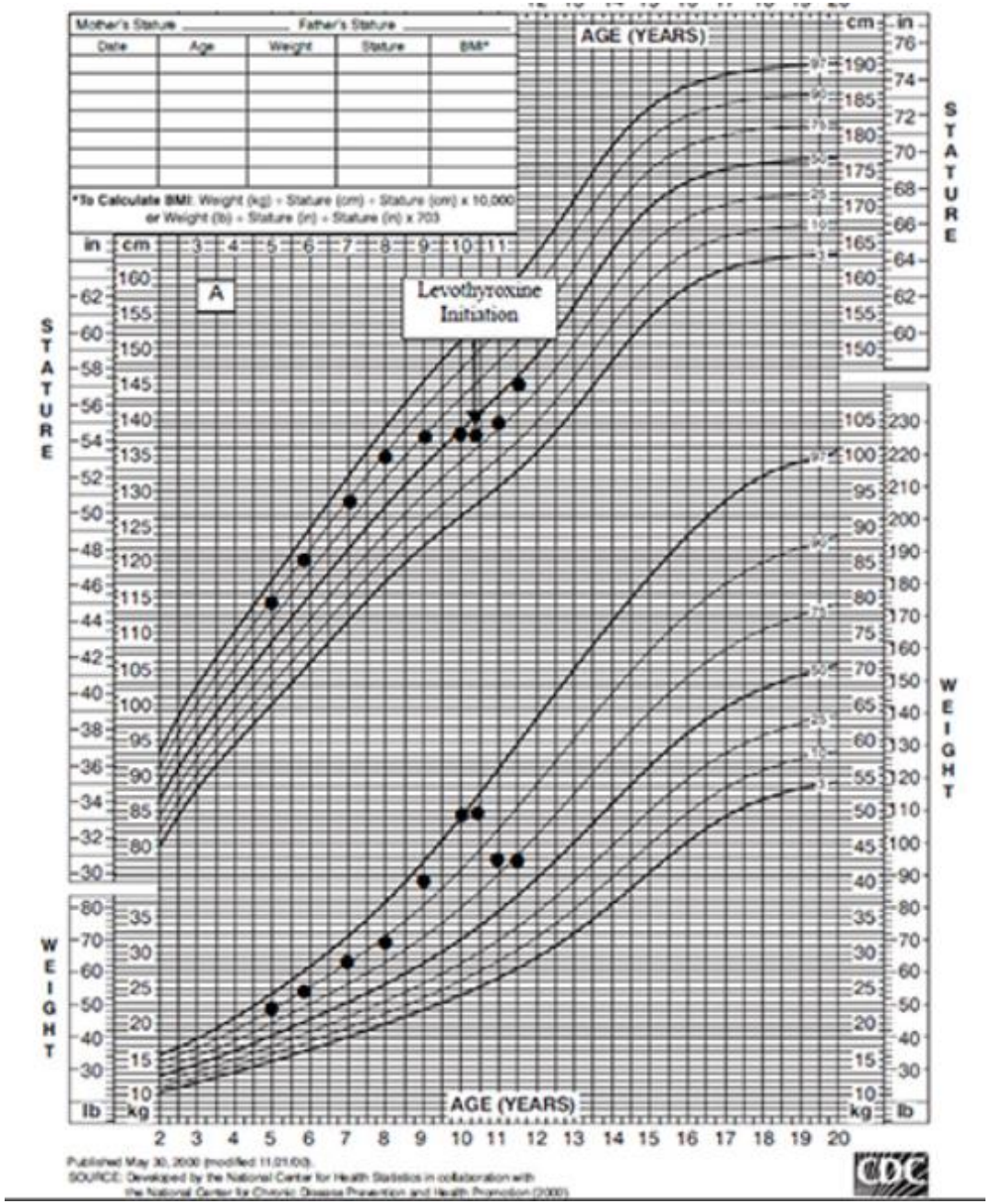
Example labs

- TSH: 22 uIU/mL (0.35-5.5)
- FT4: 1.0 ng/dL (1.0-1.6)

Treatment

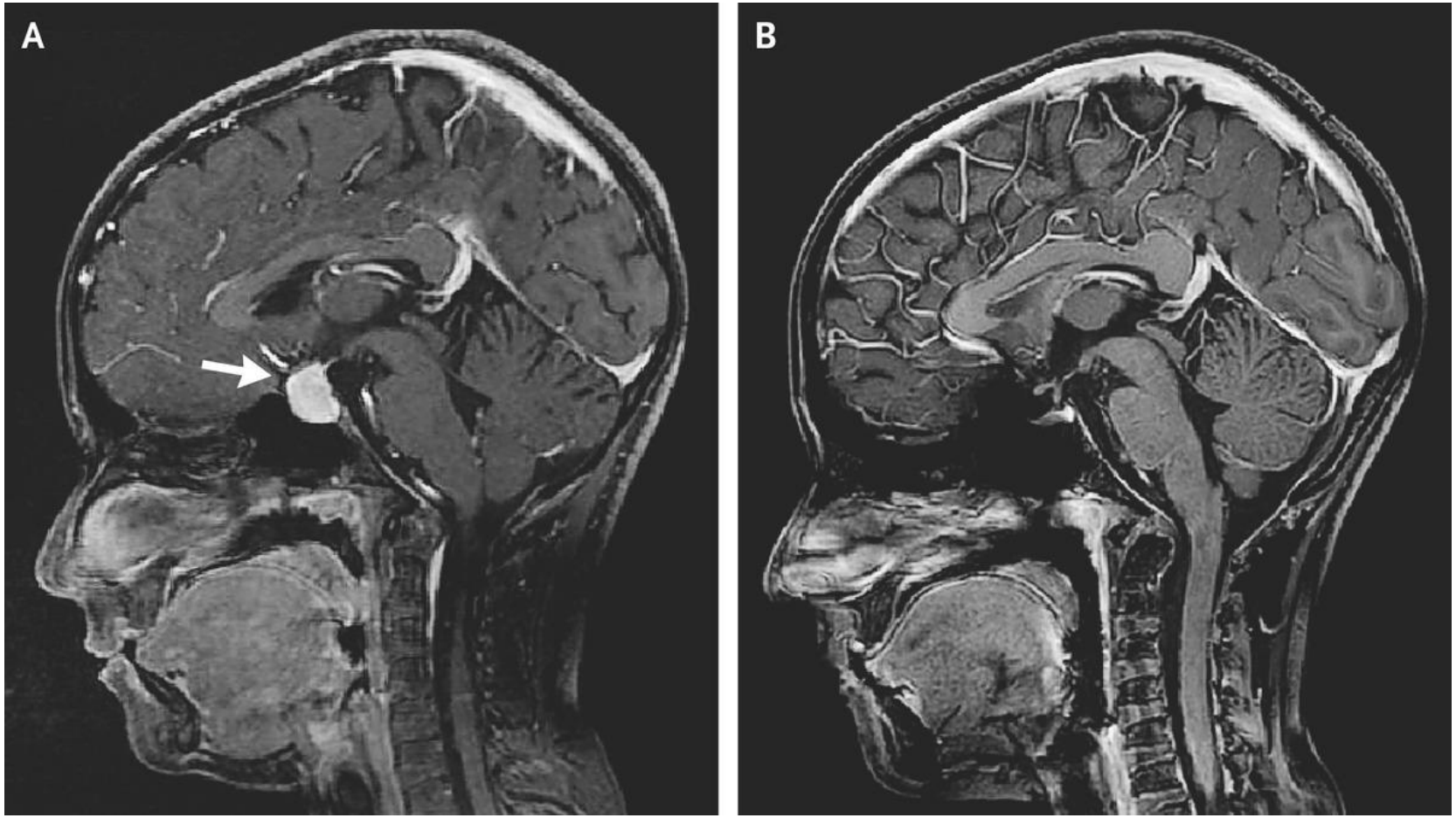
- Levothyroxine
  - There are numerous formulations with minimal differences between them
  - Given as a once daily
    - Evening: lower TSH and higher FT4? Can be “activating”
  - Avoid giving with iron, soy, calcium containing products
  - Consistency is key

Bolk N, Visser TJ, Nijman J, Jongste, RN IJ, Tijssen JGP, Berghout A. Effects of Evening vs Morning Levothyroxine Intake: A Randomized Double-blind Crossover Trial. *Arch Intern Med.* 2010;170(22):1996–2003. doi:10.1001/archinternmed.2010.436



Schumaker T, Censani M. Growth Failure and Excessive Weight Gain in a 10 Year Old Male With Obesity: Approach to Diagnosis, Management, and Treatment of Acquired Hypothyroidism. *Front Pediatr*. 2018;6:166. Published 2018 Jun 19. doi:10.3389/fped.2018.00166

Pituitary Hyperplasia from Primary Hypothyroidism



K Shivaprasad, K Siddardha. N Engl J Med 2019;380:e

Subclinical Hypothyroidism

- Normal FT4 and T3 but elevated TSH
- Reference ranges: adult v pediatric
- Mild elevation of TSH: 5-10 uU/mL
  - Few progress to TSH >10 uU/mL
  - Treatment does not demonstrate benefit
  - Most spontaneously resolve on repeat testing

-Sperling, M. *Pediatric Endocrinology*. Philadelphia, PA: Saunders/Elsevier, 2020
-Cerbone M, et al, Linear growth and intellectual outcome in children with long-term idiopathic subclinical hypothyroidism. Eur J Endocrinol. 2011 Apr;164(4):591-7. doi: 10.1530/EJE-10-0979. Epub 2011 Feb 3. PMID: 21292920.
-Wasniewska M, et al. Prospective evaluation of the natural course of idiopathic subclinical hypothyroidism in childhood and adolescence. Eur J Endocrinol. 2009 Mar;160(3):417-21. doi: 10.1530/EJE-08-0625. Epub 2008 Dec 12. PMID: 19074464.

Case

- A 16-year-old female comes with concern of anxiety and irritability. She has had trouble falling asleep and has had unintentional weight loss.
- ROS + for loose stool, intermittent palpitations
- ROS – for fever, altered mental status, chest pain
- Just anxiety?
  - Prevalence 7.1% in 2019 in ages 3-17

Ghandour RM, Sherman LJ, Vladutiu CJ, Ali MM, Lynch SE, Bitsko RH, Blumberg SJ. Prevalence and treatment of depression, anxiety, and conduct problems in U.S. children. *The Journal of Pediatrics*, 2019;206:256-267

Primary Hyperthyroidism

- Signs and symptoms:
  - Tachycardia, heat intolerance, anxiety, irritability, diaphoresis, tremor, weight loss, sleep disturbance, diarrhea
- DDx:
  - Graves disease, Hashitoxicosis, infection, levothyroxine ingestion, McCune Albright, improperly processed meat!

Hedberg CW, Fishbein DB, Janssen RS, Meyers B, McMillen JM, MacDonald KL, White KE, Huss LJ, Hurwitz ES, Farhie JR, et al. An outbreak of thyrotoxicosis caused by the consumption of bovine thyroid gland in ground beef. N Engl J Med. 1987 Apr 16;316(16):993-8. doi: 10.1056/NEJM198704163161605. PMID: 3561455.

Hyperthyroidism: Graves

- Most common:
  - Prevalence 1 in 10,000 children
- Ab: positive for Trab/TSI
- Pathophysiology:
  - Thyroid gland stimulation by ab
- Exam:
  - Goiter, bruit, tachycardia, exophthalmos, lid lag

Sperling, M. *Pediatric Endocrinology*. Philadelphia, PA: Saunders/Elsevier, 2020

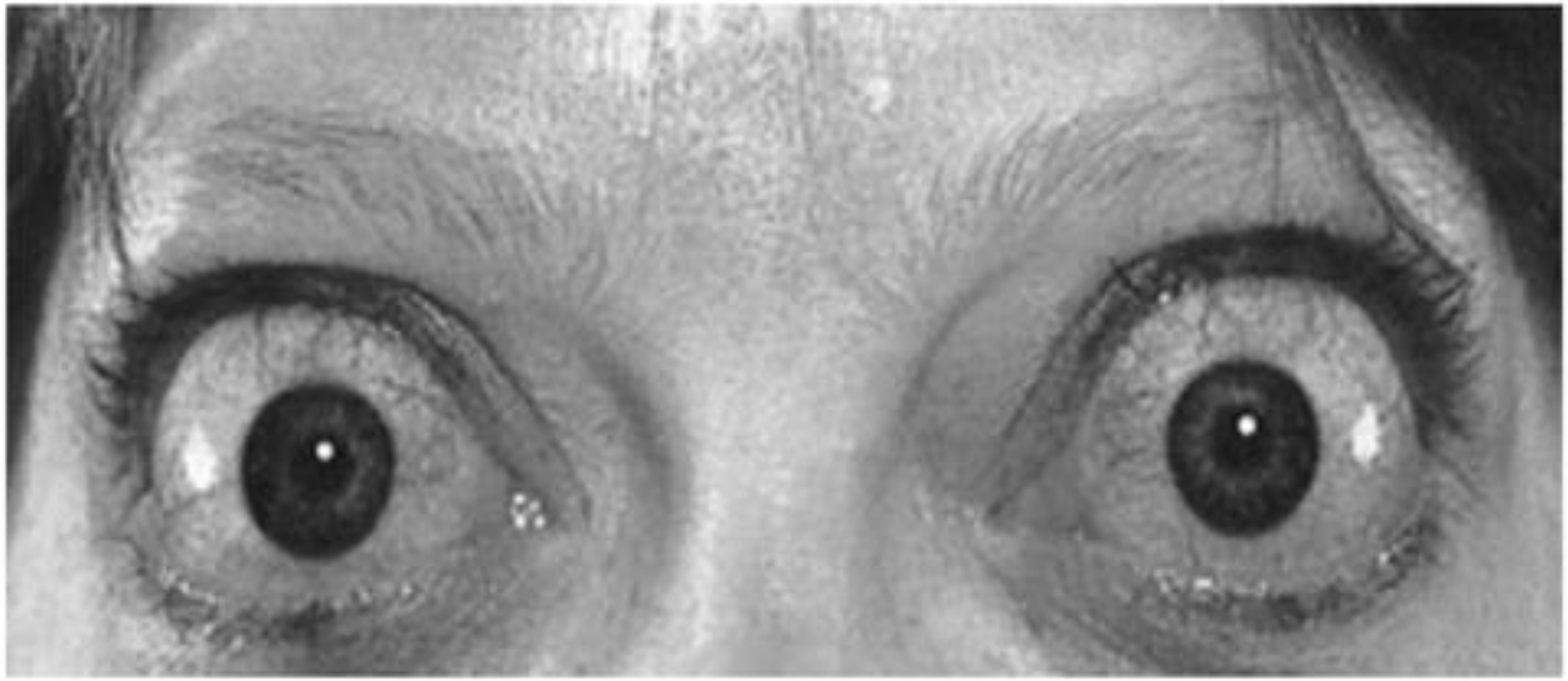
Symptoms

- Hyperactivity
- Diarrhea
- Diaphoresis
- Tremulousness
- Sleep disturbance
- Poor weight gain
- Irregular menses
- Peri-orbital edema
- Hypertension
- Goiter
- Cholestasis
- Thrombocytopenia
- Cognitive changes
- Muscle weakness

Example Labs

- TSH: < 0.010 uIU/mL (0.35-5.5)
- FT4: 8.1 ng/dL (0.8-1.4)
- T3: >651 ng/dL (91-218)

Typical presentation of Graves' orbitopathy showing marked stare, proptosis, and conjunctival inflammation



Courtesy of Terry Davies, MD, FRCP, FACE.

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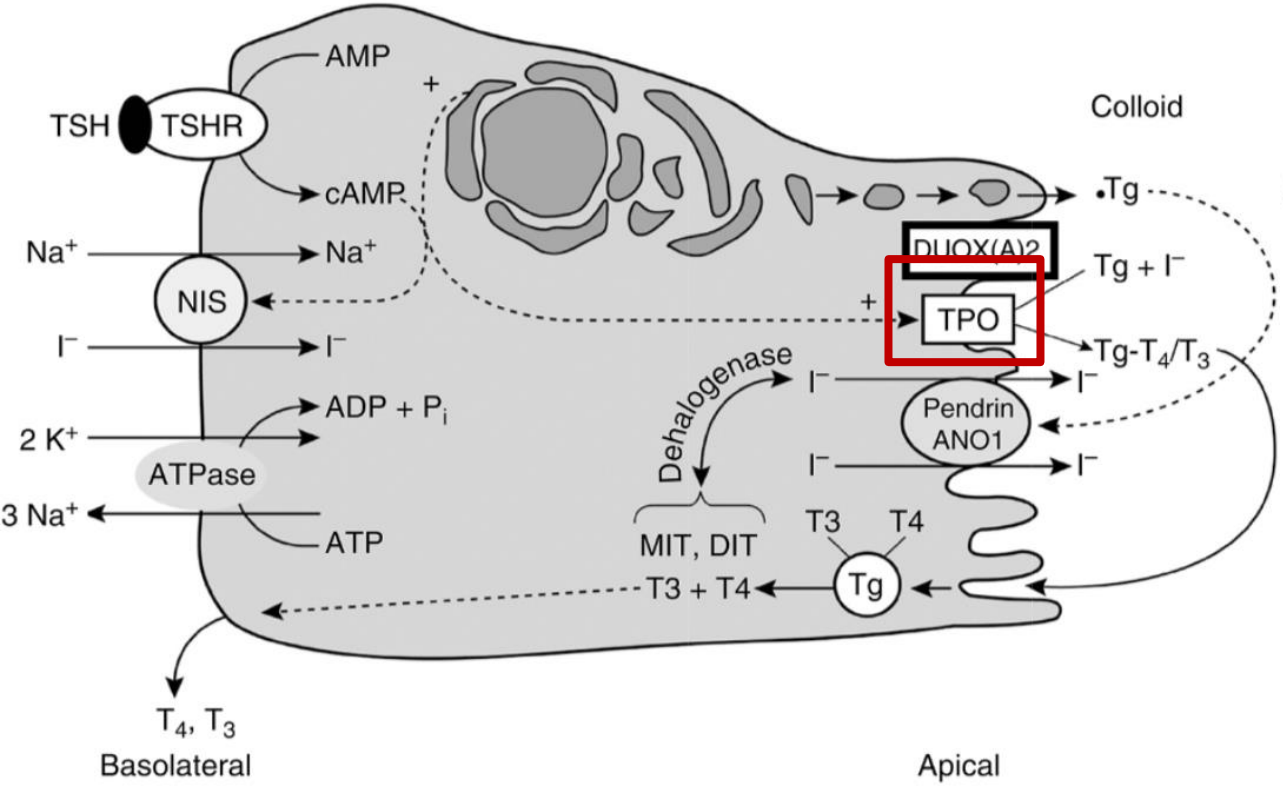
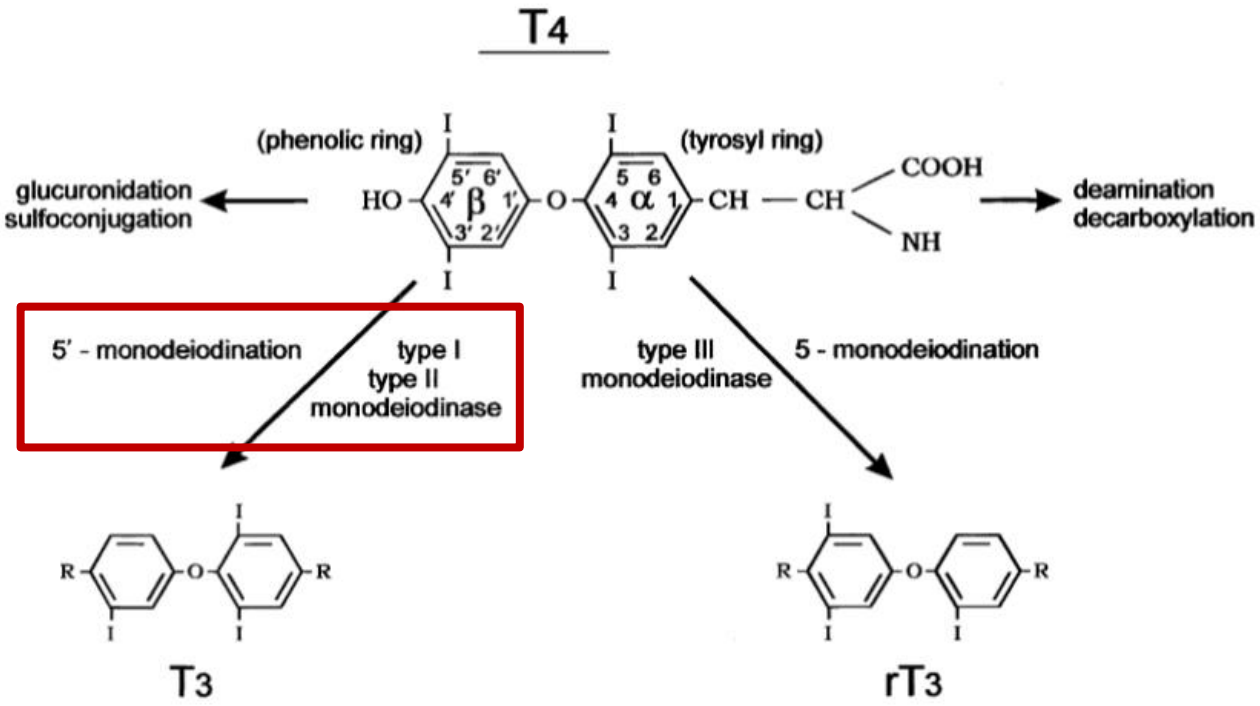
Weetman AP. N Engl J Med 2000;343:1236-124

Treatment


AMP
TSH
TSHR
cAMP
Na+
Na+
NIS
I−
I−
2 K+
ADP + Pi
ATPase
3 Na+
ATP
T4, T3
Basolateral
Colloid
•Tg
DUOX(A)2
Tg + I−
TPO
Tg-T4/T3
Dehalogenase
I−
I−
Pendrin
ANO1
I−
I−
MIT, DIT
T3
T4
T3 + T4
Tg
Apical


T4
(phenolic ring)
(tyrosyl ring)
glucuronidation
sulfoconjugation
HO
O
CH
CH
COOH
NH
deamination
decarboxylation
5' - monodeiodination
type I
type II
monodeiodinase
type III
monodeiodinase
5 - monodeiodination
R
O
R
T3
rT3

Treatment

- Geared towards severity
- Antithyroid +/- beta blocker +/- glucocorticoid
- Methimazole and PTU
  - PTU has a black box warning: rapid irreversible liver injury
  - Methimazole: hives, arthralgia, agranulocytosis, SJS, vasculitis
  - MMU teratogenic during first trimester
  - Palliation rather than treatment

Sperling, M. *Pediatric Endocrinology*. Philadelphia, PA: Saunders/Elsevier, 2020

Definitive treatment

- Total thyroidectomy
  - parathyroid “stunning” or permanent hypoparathyroidism
  - Recurrent laryngeal nerve trauma
- Radioiodine
  - Needs to have access to their own bathroom
  - Need for repeat dosing
  - Possible exacerbation of Graves eye disease

Hyperthyroidism and Mental Health Conditions

- There is an association, not clear causation, of hyperthyroidism and some mental health conditions:
  - ADHD
  - Adjustment disorder
  - Anxiety
  - Bipolar disorder
  - Depression
  - Suicidality

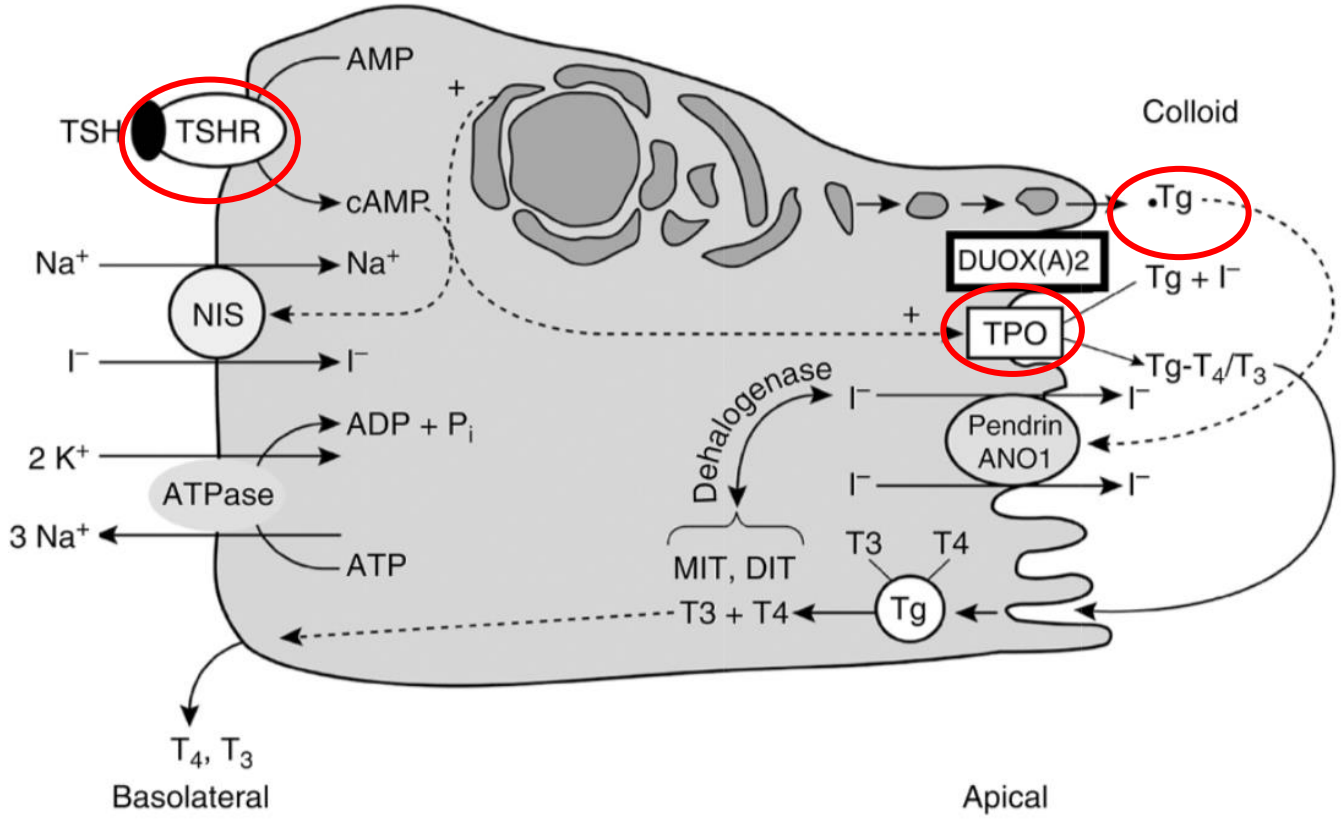
Zader SJ, Williams E, Buryk MA. Mental Health Conditions and Hyperthyroidism. Pediatrics. 2019 Nov;144(5):e20182874. doi: 10.1542/peds.2018-2874. Epub 2019 Oct 3. PMID: 31582535.

Thyroid antibody testing

- Anti-thyroid Ab Profile
  - Anti-thyroglobulin Ab, Anti-thyroidperoxidase
  - Seen usually in hypothyroid but can be in hyperthyroid
- Thyroid Stimulating Immunoglobulin
  - Present only in Graves
  - Detectable in only 90%
- TSH receptor ab
  - Can be blocking, neutral, or activating
  - Can cross the placenta

Hypothalamic-pituitary-thyroidal axis

Thyroid follicular cells



Disorders of the thyroid in the newborn and infant. In: *Pediatric Endocrinology*, M. Sperling, ed. 3rd ed., Saunders, Philadelphia

Akron Children's Hospital

Antibodies

- Portent of disease to come?
- 5% of healthy adults with ab positivity (anti-TPO and anti-thyroglobulin); <10% of the 5% went on to have disease
- Risk: anti-TPO > anti-thyroglobulin
- 20% of children with ab went on to develop hypothyroidism
  - Unclear what prevalence is of ab positivity

Watchful waiting

- If ab status is positive with normal thyroid function:
  - One can monitor TSH and FT4 at q 6-12 month intervals
  - Also, obtain labs if symptoms develop or concern from family

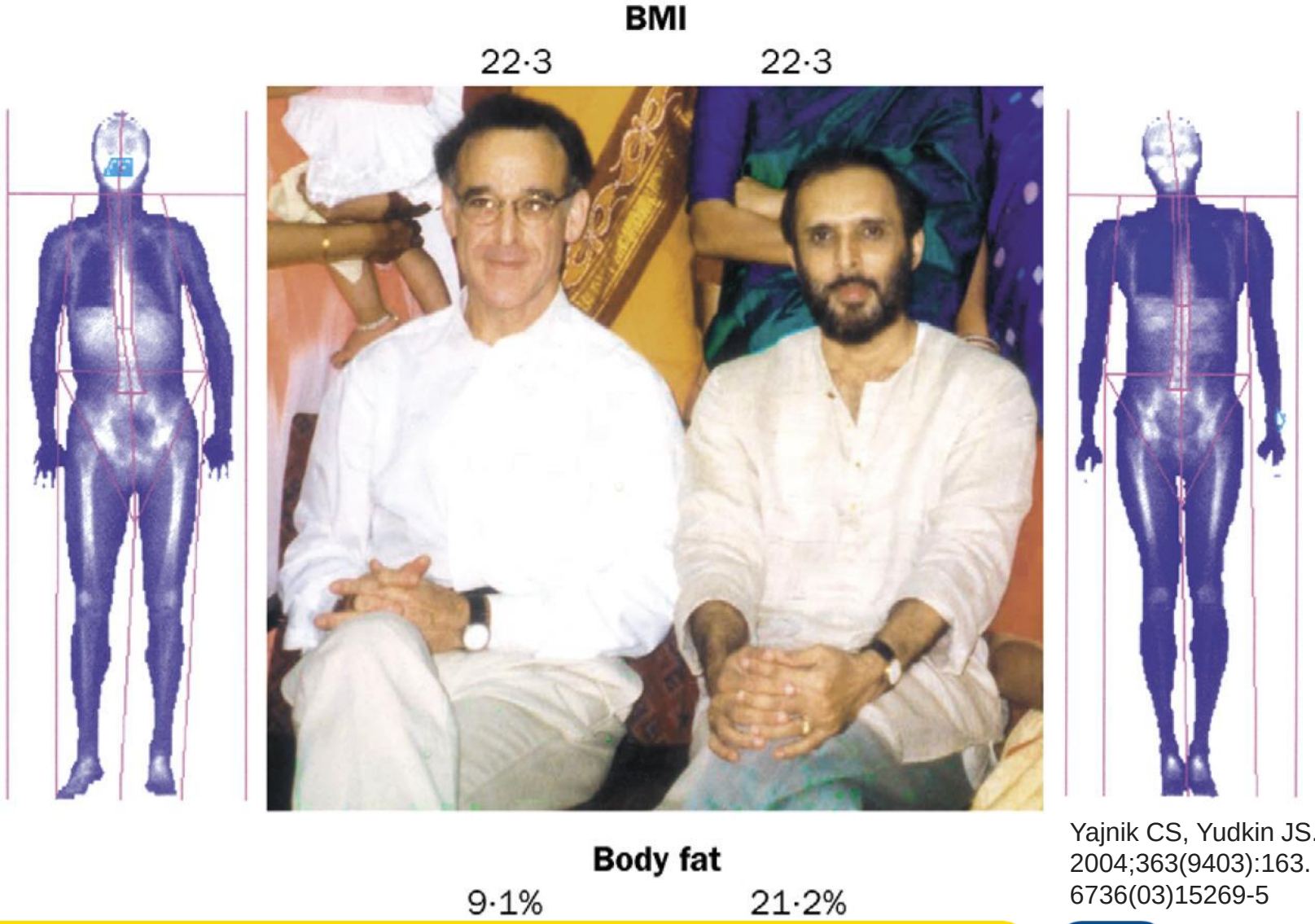
Obesity

- Physiology of obesity is it's own lecture
- BMI: weight in kg /height in m^2

Weight Status Category	Percentile Range
Underweight	Less than the 5th percentile
Healthy Weight	5th percentile to less than the 85th percentile
Overweight	85th to less than the 95th percentile
Obesity	95th percentile or greater

https://www.cdc.gov/obesity/basics/childhood-defining.html

The Y-Y paradox



Yajnik CS, Yudkin JS. The Y-Y paradox. *Lancet*. 2004;363(9403):163. doi:10.1016/S0140-6736(03)15269-5

Akron Children's Hospital

Prevalence: 2017-2018

- Children and adolescents 2-19 years: 19.3% and affected about 14.4 million children and adolescents.
- Obesity prevalence
  - 25.6% among Hispanic children
  - 24.2% among non-Hispanic Black children
  - 16.1% among non-Hispanic White children
  - 8.7% among non-Hispanic Asian children

https://www.cdc.gov/obesity/data/childhood.

Thyroid function and Obesity

- Hypothyroidism does not cause obesity
  - Unless in very rare instances: Van Wyk Grumbach syndrome – short stature, delayed bone age, precocious puberty, significant elevation of TSH (i.e >100)
- Mild elevations of TSH resolve with weight loss
  - Comparing obese v non obese patients
  - Leptin drive elevation of TSH
  - Does not warrant therapy

-Salerno M, Improda N, Capalbo D. MANAGEMENT OF ENDOCRINE DISEASE Subclinical hypothyroidism in children. Eur J Endocrinol. 2020 Aug;183(2):R13-R28 doi: 10.1530/EJE-20-0051. PMID: 32580145.
-Yadav J, Jain N, Dayal D. Alterations of thyroid function in overweight and obese children: An update. Indian J Child Health. 2018;5:145-50
-Dayal D, Kumar TS. High Prevalence of Thyroid Dysfunction in Children with Simp Obesity. Indian Pediatr. 2019 Apr 15;56(4):331. PMID: 31064907.

When is it endocrine?

CLINICAL PRACTICE GUIDELINE

Pediatric Obesity—Assessment, Treatment, and Prevention: An Endocrine Society Clinical Practice Guideline

Dennis M. Styne,[1] Silva A. Arslanian,[2] Ellen L. Connor,[3] Ismaa Sadaf Farooqi,[4] M. Hassan Murad,[5] Janet H. Silverstein,[6] and Jack A. Yanovski[7]

[1]University of California Davis, Sacramento, California 95817; [2]University of Pittsburgh, Pittsburgh, Pennsylvania 15224; [3]University of Wisconsin, Madison, Wisconsin 53792; [4]University of Cambridge, Cambridge CB2 0QQ, United Kingdom; [5]Mayo Clinic, Rochester, Minnesota 55905; [6]University of Florida, Gainesville, Florida 32607; and [7]National Institutes of Health, Bethesda, Maryland 20892

1.5 We recommend against routine laboratory evaluations for endocrine etiologies of pediatric obesity unless the patient's stature and/or height velocity are attenuated (assessed in relationship to genetic/familial potential and pubertal stage). (1|⊕⊕⊕○)

Physical Activities by Age

Infants	Toddlers	Preschoolers	Elementary students	Middle schoolers	Teenagers
Tummy time while awake.	Neighborhood walks or free play outside.	Tumbling, throwing, & catching.	Free play and organized sports focused on fun.	Activities that encourage socialization. Avoid specializing in one sport.	Activities that encourage socialization and competition, when appropriate.
30+ minutes throughout day.	3+ hours throughout day.	3+ hours a day, including 1 hour of moderate to vigorous activity.	60+ minutes of activity most days. Muscle/bone strengthening activities 3 days a week.	60+ minutes of activity most days. Muscle/bone strengthening 3 days a week.	60+ minutes of activity most days. Muscle/bone strengthening 3 days a week.

American Academy of Pediatrics
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POLICY STATEMENT

Strength Training by Children and Adolescents

Organizational Principles to Guide and Define the Child Health Care System and/or Improve the Health of All Children

Council on Sports Medicine and Fitness

Misconceptions	Evidence
A child is unable to increase strength before puberty.	Prepubertal children are able to gain strength by an increase in neurologic recruitment of muscle fibers, and gains in strength can be made with low injury rates if resistance training programs are well supervised with an emphasis on proper technique.
Young boys and girls may get "muscle bound" if they resistance train.	Prepubertal strength gains occur by neurologic mechanisms, and pubertal gains may augment muscle growth by actual muscle hypertrophy enhanced by pubertal hormones.
Resistance training may decrease aerobic performance in youth.	Improvements in aerobic performance have been shown with combined aerobic and resistance training programs, and combined aerobic and resistance programs do not appear to impair strength gains in children.
Resistance training may stunt growth.	Well-designed resistance training programs have not been shown to have a negative effect on physeal (growth plate) health, linear growth, and cardiovascular health in youth.
Children are stronger now than ever before.	There is a need to target strength deficits and build strength reserves due to declining measures of muscular fitness in modern-day youth.

Paul R. Stricker et al; Resistance Training for Children and Adolescents. *Pediatrics* June 2020; 145 (6): e20201011. 10.1542/peds.2020-1011

Thyroid Emergencies

- Thyroid Storm
- Myxedema coma
- Newborn screen

Thyroid Storm

- Incidence is 1-3%
- Mortality ~10% or higher
- Caused by any form of thyrotoxicosis
- Burch-Wartofsky Point Scale
  - Point scale assessing the likelihood of impending thyroid storm
  - Temperature, tachycardia,AFIB, CHF, GI/hepatic dysfunction, CNS disturbance, precipitating factor
  - In setting of corroborating thyroid function tests

Point Scale for the Diagnosis of Thyroid Storm

Thermoregulatory dysfunction

Temperature (8F)	
99.0–99.9 5	0
100.0–100.9	10
101.0–101.9	15
102.0–102.9	20
103.0–103.9	25
>104.0	30

Cardiovascular

Tachycardia (beats per minute)	
100–109	5
110–119	10
120–129	15
130–139	20
>140	25

Atrial fibrillation

Absent	0
Present	10

Congestive heart failure

Absent	0
Mild	5
Moderate	10
Severe	20

Gastrointestinal-hepatic dysfunction

Manifestation	
Absent	0
Moderate (diarrhea, abdominal pain, nausea/vomiting)	10
Severe (jaundice)	20

Central nervous system disturbance

Manifestation	
Absent	0
Mild (agitation)	10
Moderate (delirium, psychosis, extreme lethargy)	20
Severe (seizure, coma)	30

Precipitant history

Status	
Positive	0
Negative	10

Scores totaled

>45 Thyroid storm

25–44 Impending storm

<25 Storm unlikely

De Groot LJ, Bartalena L, Feingold KR. Thyroid Storm. [Updated 2018 Dec 17]. In: Feingold KR, Anawalt B, Boyce A, et al., editors. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK278927/

Burch-Wartofsky Point Scale

Case 1:
TSH <0.01; FT4 8.1; T3 651

- Anxious: 10
- HR 115 bpm: 10
- No afibrillation/congestive heart failure: 0
- No hx of infection: 0
- Afebrile: 0
- No GI distress: 0
- Burch-Wartofsky Point Scale: 20
  - Storm Unlikely

Case 2
TSH < 0.015; FT4 1.7; T3 134

- Anxious: 10
- HR 88 BPM: 0
- No afib/CHF: 0
- No hx of infection: 0
- Afebrile: 0
- No GI distress: 0
- Burch-Wartofsky total: 10
  - Storm unlikely

Myxedema Coma

- Incidence: 0.22 cases per million people per year in all ages
  - Incredibly rare in pediatrics: few reported cases
- Mortality: some reported as high as 60%
- Presentation:
  - AMS, respiratory failure, bradycardia, hypothermia, hypotension, hypoglycemia, failure to thrive

Heksch RA, Henry RK. Myxedema Coma due to Hashimoto Thyroiditis: A Rare but Real Presentation of Failure to Thrive in Infancy. Horm Res Paediatr.

Considerations

- Thyroid function tests will be abnormal during critical illness
  - Do not test thyroid function unless you are convinced thyroid is the etiology
- Primary hypothyroidism:
  - TSH elevation in case reports demonstrably high >100uIU/mL
- Secondary hypothyroidism v sick euthyroid
  - Reverse T3

Treatment

- Limited pediatric data
- Levothyroxine replacement + glucocorticoid therapy
- Adrenal Crisis
  - Increased glucocorticoid clearance with levothyroxine
  - Normal cortisol prior to levothyroxine does not necessarily mean absence of adrenal insufficiency

Newborn screen: congenital hypothyroidism

- Prior offensive terminology: cretin
- Incidence
  - Pre NBS: 1 in 7,000 live births
  - Post NBS in 1970's: 1 in 4,000 live birth
  - Most recently: 1 in 2,500 live birth
- Incidence higher in Hispanic
- 2:1 Female to Male predominance

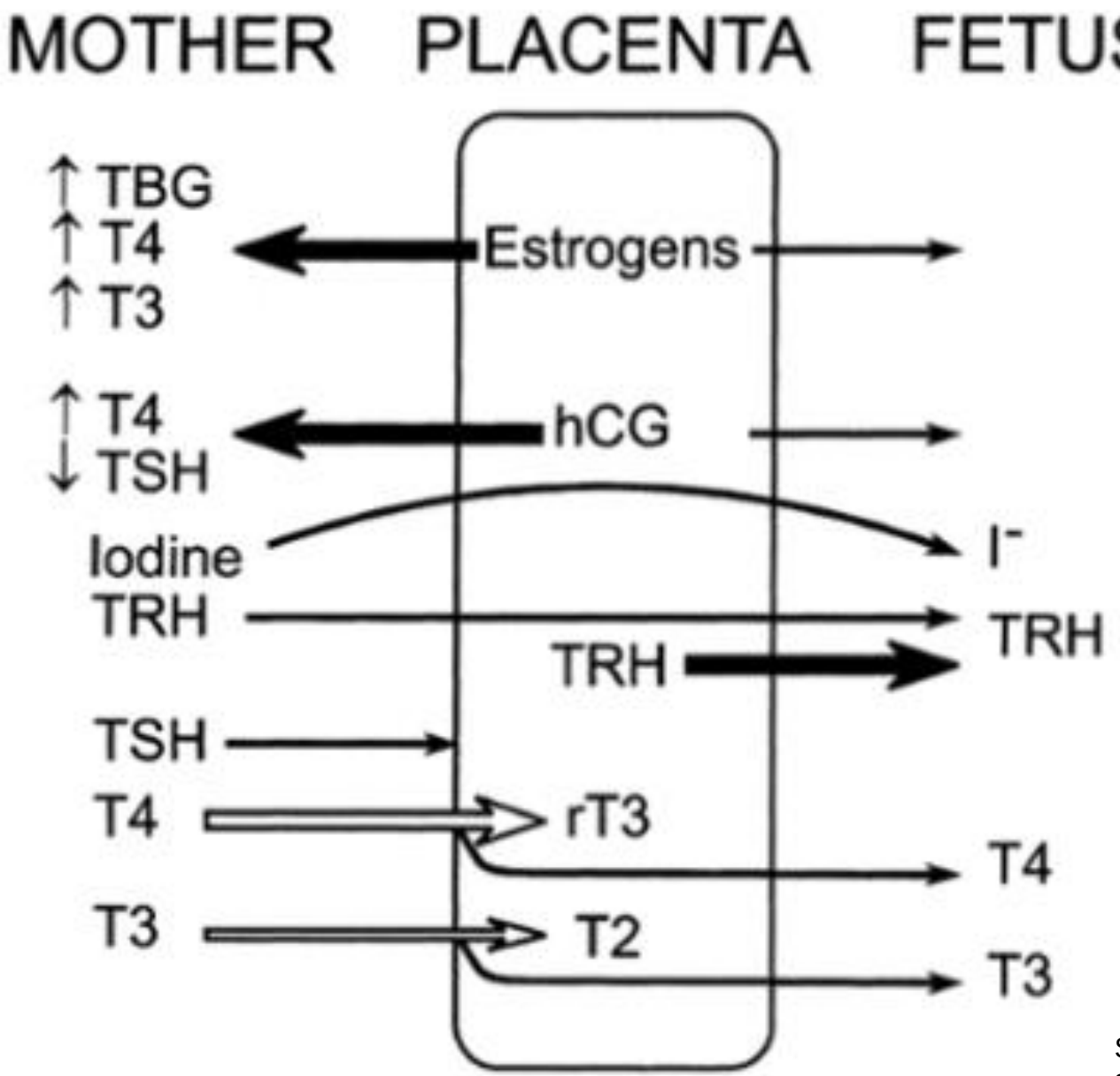
Common Causes

- Thyroid dysgenesis
  - Ectopic 1:5,000
  - Athyreosis 1: 15,000
- Dyshormonogenesis 1:30,000
- Thyroid hormone resistance: 1:40,000

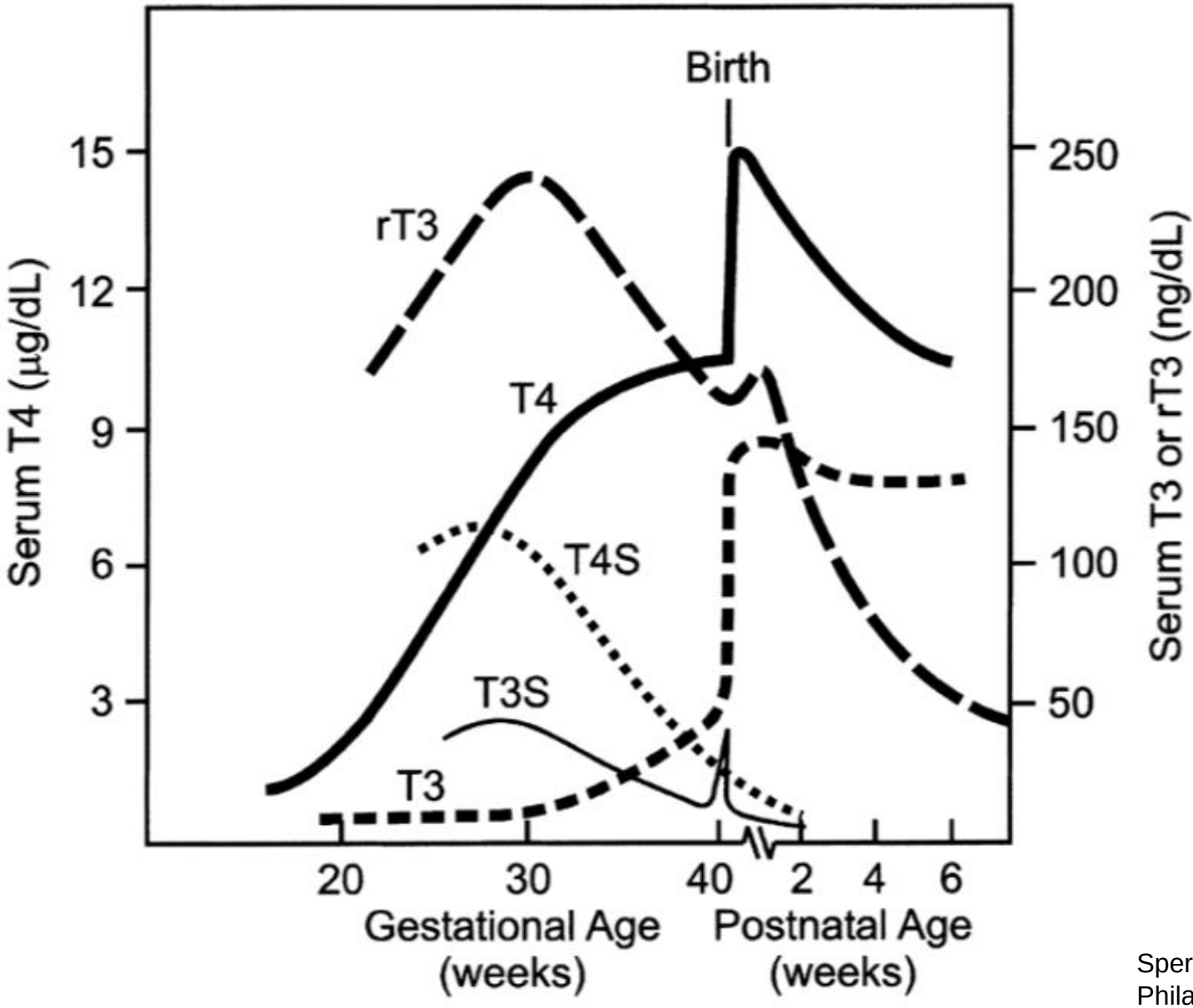
Sperling, M. *Pediatric Endocrinology*. Philadelphia, PA: Saunders/Elsevier, 2020

Embryology

- Median anlage + 2 lateral anlage
  - Pharyngeal floor and fourth pharyngeal pouches respectively
  - Visible by day 17; fused by day 50
- Migration
  - Movement due to surrounding tissues; caudal descent
- Function
  - At 70 days capable of iodine capture and iodothyronine synthesis



Sperling, M. *Pediatric Endocrinology*. Philadelphia, PA: Saunders/Elsevier, 2020



Sperling, M. *Pediatric Endocrinology*. Philadelphia, PA: Saunders/Elsevier, 2020

- TSH peak at 30 minutes = ~70 mU/L
- Rapid decline in 24 hours
- Reach 5-10 IU/L usually within the first week of life

Presentation

- Variable
  - Classic signs and symptoms are often delayed
  - Birth parameters are usually normal
  - But
    - Lethargy
    - Feeding issues
    - Constipation
    - Myxedema
    - hypotonia

Umbilical hernia

Large fontanelle

Prolonged jaundice

Goyal C, Naqvi W. Developmental delay in congenital hypothyroidism. *Pan Afr Med J*. 2021;38:165. Published 2021 Feb 12. doi:10.11604/pamj.2021.38.165.27321

Calcaterra V, Lamberti R, Viggiano C, et al. Neonatal Dyshormonogenetic Goiter with Hypothyroidism Associated with Novel Mutations in Thyroglobulin and SLC26A4 Gene. *Pediatr Rep*. 2021;13(2):210-215. Published 2021 May 2. doi:10.3390/pediatric13020029

Treatment

- Aim to start by 2 weeks of age
- TSH goal: age appropriate normal
- FT4 goal: upper half of age appropriate normal
- Levothyroxine tablet
  - 10-15 mcg/kg/day
  - Crushed and mixed with water, administer by syringe

From: **Case Report: The Specter of Untreated Congenital Hypothyroidism in Immigrant Families**

Pediatrics. 2016;137(5). doi:10.1542/peds.2015-3418

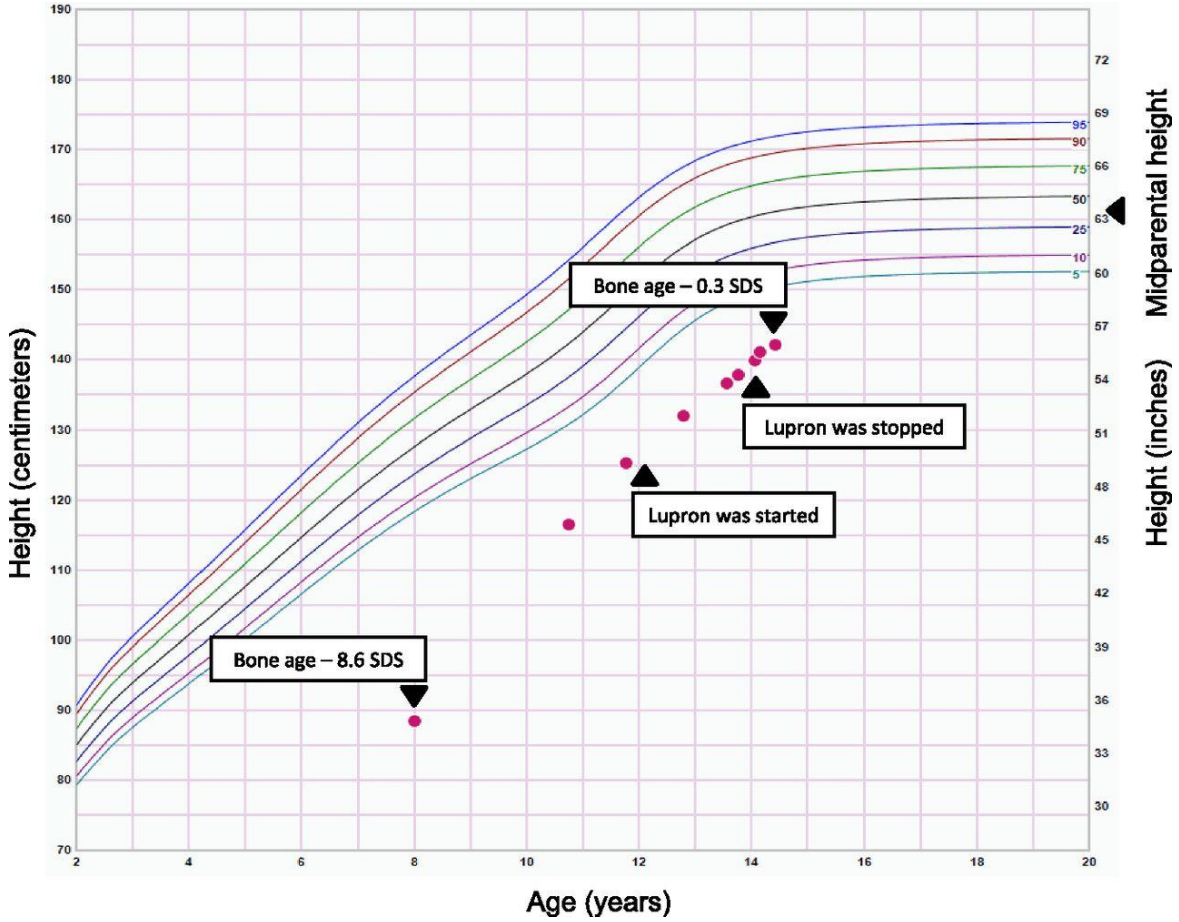


Figure Legend:

Patient 2 growth chart: stature-for-age percentiles with bone age, midparental height, and duration of Lupron therapy data.

- Cognitive development: permanent loss of IQ
- Mean IQ prior to CH screening: 76
- Mean IQ after implementation: 104

Simoneau-Roy J, Marti S, Deal C, Huot C, Robaey P, Van Vliet G. Cognition and behavior at school entry in children with congenital hypothyroidism treated early with high-dose levothyroxine. *J Pediatr*. 2004;144(6):747-752. doi:10.1016/j.jpeds.2004.02.021

Summary Slide

- TSH < 10 with a normal FT4 usually spontaneously resolves
- Treatment of TSH < 10 doesn't necessarily improve the symptoms that spurred you to check
- Use age-appropriate reference ranges

↑ TSH, ↓ FT4	Primary Hypothyroidism
↓ TSH, ↑ FT4	Primary Hyperthyroidism

Questions