Learning Objectives:

- Understand what factors control the release of thyroid hormone
- Know what thyroid hormone does, as well as what to expect in excess or deficient levels of thyroid hormone
- Understand the role of iodine in thyroid hormone
- Know the basics of thyroid medications
Thyroid Hormone

- The thyroid gland is part of the endocrine system
- A hormone is a signaling molecule secreted from a gland
  - Thyroid hormone is secreted from the thyroid gland
- A hormone’s target is usually far from its site (gland) of secretion
- Hormones must be transported to their targets by the blood in the circulatory system
Thyroid Hormone - In the body

- **Hormones involved**
  - **TRH**
    - Thyrotropin releasing hormone: Synthesized by the hypothalamus and stimulates the release of TSH
  - **TSH**
    - Thyroid stimulating hormone: Synthesized by the anterior pituitary and stimulates the release of TH
  - **TH**
    - Thyroid hormone
      - T3 & T4
  - **SST**
    - Somatostatin: Inhibitory hormone released by the hypothalamus
What does thyroid hormone do?

- Regulates growth
- Cerebral development, mental dulling, or hyperexcitability
- Regulates metabolic rate
- Increase cholesterol synthesis & cholesterol excretion into the bile
- Effect protein mass
- Increase GI motility and secretion of gastric fluids
- Helps maintain water and electrolyte balance
- Increase or decrease need for oxygen in the periphery leading to an increase or decrease in cardiac output
- Hyperactive muscle reactions - muscle sluggishness
- Helps regulate temperature
- Helps maintain the reproduction cycle and contents of breast milk
Thyroid hormone

Liver: Type 1 deiodinase

Tyrosine

Thyroxine (T4)  Triiodothyronine (T3)  "Reverse T3" (inactive)
Drugs & Thyroid Hormone

- Drugs that effect thyroid hormone levels:
  - Enzyme inducers:
    - Rifampin, carbamazepine, and phenobarbital
      - Decrease thyroid hormone levels
  - Drugs that contain iodine
    - Amiodarone - can cause hyperthyroidism
- How thyroid hormones effect drugs
  - Hyperthyroidism
    - Increases: warfarin
    - Decreases: digoxin, benzodiazepines, & opiates
  - Hypothyroidism
    - Decreases: warfarin
    - Increases: digoxin, benzodiazepines, & opiates
Hypothyroidism

- Primary (thyroid), secondary (pituitary), tertiary (hypothalamus)
  - 1 - Low T3 & T4, high TSH, 2 & 3 (Low T3, T4, & TSH)
- Goiter
  - Iodine deficiency
- Children
  - Cretinism: Dwarfism and mental retardation - reversible with adequate amounts of thyroid hormone given early enough in life
- Adults - severe
  - Myxedema: Coma, hypotension, hypoventilation, hypothermia, bradycardia, hyponatremia, and hypoglycemia
- Classic presentation
  - Dry skin, cold intolerance, lethargy, depression, and weight gain
Hypothyroidism Medications

- **Levothyroxine (T4) - synthetic thyroid hormone**

- **Dosing:** Based on drug response, brand may be medically necessary, measured in mcg
  - IM, PO, IV

- **Kinetics:** Bioavailability 40-80%, half life varies euthyroid (7 days), hypothyroid (10 days), hyperthyroid (3 days)

- **Adverse effects**
  - Hyperthyroidism: Elevated temperature, diarrhea, hand tremors, increased irritability, CNS, tachycardia, sweating, vomiting, weight loss

- **Monitor thyroid panel**
Hypothyroidism Medications

- Liothyronine (T3) - synthetic thyroid hormone
- Dosing: Based on drug response, brand may be medically necessary, measured in mcg
  - PO, IV
- Kinetics: Incomplete intestinal absorption, 24 hour half life
- Adverse effects
  - More active form. Can be toxic monitoring important. Hyperthyroidism: Elevated temperature, diarrhea, hand tremors, increased irritability, CNS, tachycardia, sweating, vomiting, weight loss
- Monitoring: Thyroid panel - efficacy
Hypothyroidism Medications

Desiccated Thyroid
- Ground thyroid gland
- Can cause allergic reaction

Liotrix
- Mixture of T3 & T4
  - Normal circulation levels
- Expensive
- Not necessary, T4 gets converted to T3 any way
Hyperthyroidism

- Primary (thyroid), secondary (pituitary), tertiary (hypothalamus)
  - 1 - High T3 & T4, low TSH  /  2 & 3 (high T3, T4, & TSH)
- Thyrotoxicosis
  - Excess thyroid hormone circulating - toxic types of goiter or cancers that produce and excrete thyroid hormone
- Too much thyroid hormone - increased metabolic rate, temperature, and pulse, restlessness, anxiety, emotional instability
- Thyroid storm - sudden onset of hyperthyroid symptoms with emphasis on cardiovascular and CNS symptoms
- Causes serious cardiovascular disease - afib, heart failure, osteoporosis, liver failure, neurologic irritability
**Hyperthyroidism Medications**

- **Propylthiouracil (PTU) - Thioamide derivative**
- **MOA:** Does not effect exogenous thyroid hormone, inhibits the synthesis of thyroid hormone by inhibiting iodide incorporation into tyrosine and the coupling of iodothyrosines * inhibits the conversion of T4 to T3
- **Uses:** Hyperthyroidism, prior to radiotherapy surgery, or an adjunct to thyroid storm
- **Kinetics:** PTU has a half life of only 1-2 hours but its peak effect is not seen until 17 weeks, metabolized in the liver and excreted by the kidneys
- **Dosing:** Based on age - children between 6 & 10 years is 50-150 mg daily, children over 10 years 50-300 mg, and adults 300-900 mg daily in divided doses
- **Adverse effects:** Loss of taste, nausea, vomiting, dizziness, skin rash, fever, signs of infection secondary to leukopenia or agranulocytosis
- **Can cross the placenta**
Hyperthyroidism Medications

- **Methimazole**  - Thioamide derivative
- **MOA:** Does not effect exogenous thyroid hormone, inhibits the synthesis of thyroid hormone by inhibiting iodide incorporation into tyrosine and the coupling of iodotyrosines
- **Uses:** Treatment of hyperthyroidism before surgery and hyperthyroidism
- **Kinetics:** Half life 5-6 hours - peak 7 weeks, metabolized in the liver and excreted by the kidneys
- **Dosing:** Adult (maintenance) 5-30 mg in 1-2 divided doses, pediatric maintenance dose should not exceed 30 mg/day - but is generally bases on weight 0.2 mg/kg/day
- **ADRs:** Similar to PTU  Loss of taste, nausea, vomiting, dizziness, skin rash, fever, signs of infection secondary to leukopenia or agranulocytosis
- **Can cross the placenta**
Iodine

- **Potassium iodide**
  - Uses: Reduce the vascularity of thyroid prior to removal, goiter, complete with radioactive thyroid for uptake
  - ADRs: “Iodism” - rash, goiter, flulike symptoms, swelling of salivary glands, mucus membrane ulceration, confusion/depression, nausea and diarrhea

- **Sodium I131 (radio active iodide)**
  - Uses: Thyroid storm/thyroid cancer
  - ADRs: Swelling, rash leukocyte infiltration,
  - Interactions: Antithyroid agents and amiodarone - inhibit the effect of I131
QUESTIONS