Physiology Exam 9 Study Guide

Thyroid gland continued…
-Thyroid hormones (TH): T_3/T_4 – nonpolar (bind to nuclear receptors) → impact DNA
-Metabolic effects → regulate energy
-Stimulate metabolism (Increases equation 2 → produces ATP and heat)
-Ex: can stay comfy walking to class in frigid weather → maintains body temp
-Generates heat
-Enhance use of metabolic fuels (glucose, protein, fats) – Use whatever necessary to ensure engine is running properly (body)
-Enhance results of sympathetic nervous system
-Stimulates ATP/energy production needed for fight or flight response
-Less likely to escape in situation if thyroid gland issues
-Neural development
-Necessary for neurons to have environment in which they can survive
-Promote effects of growth hormone → to make a bigger you, need more energy
-Thyroid Disorders (Thyroid gland problem = most common endocrine disease)
-**Hypothyroidism** – too little T_3/T_4 production
*Commonly known as iodine deficiency worldwide → Not in US b/c it's added to table salt
*In US it is primarily due to an autoimmune disease, but on the rise due to "au-natural"
-No T_3/T_4 to do negative feedback from thyroid hormones (E3 has 3 jobs)
*$T_{0\text{-}2}$ cannot bind to receptors in nucleus (wrong shape/charge – not specific)
-When body has need for metabolic stimulation, releases TRH → TSH released → bind to receptors on follicular cells to cause production of T_3/T_4 (NOT there to do job!!!)
-Body continues to send signal b/c seeing no response of metabolic stimulation
-Leads to excess TSH secreted, low levels of T_3/T_4
-Overstimulated follicular cells – trying to become bigger gland to increase production capacity of T_3/T_4 (TSH keeps telling them to do so)
-**Goiter** – enlarged gland (in mammals too)
-Symptoms: -Cold intolerance (don't generate heat)
-Increase weight (not running metabolism)
-Fatigue more easily (no ATP generation)
-**Hyperthyroidism** – Too much T_3/T_4 production
*Commonly known as Grave's disease–autoimmune disease (soldiers we create cause problems)
-Antibodies created activate TSH receptor on follicular cells of thyroid gland
*Competitors for T_3/T_4 – same response → agonists (same shape and charge)
- T_3/T_4 doing negative feedback → decreases TSH/TRH levels → DOES NOT decrease TH production
-Ineffective on controlling production of antibody → increased TH production
- T_3/T_4 don't affect immune system (can't stop antibodies)
-Enlarged gland → **goiter**
-Symptoms: -Heat intolerant (already producing lot of heat)
-Losing weight (revving that furnace)
-Increases sympathetic activity (tons of energy, quick flight/fight response)
Adrenal Gland – named as a result of anatomy, not physiology
-Sits above kidney (renal) → but NOT associated with kidney function

-Production: CRH (E1) → APG releases ACTH (E2) → adrenal gland releases corticosteroids (**Cortisol = E3)**
-Actions: Mediates stress (historically → about food)
-Cortisol turns on system → assumes you are starving
-Focuses on short-term energy levels (NOW) → enough to survive
*How does **cortisol** help maintain energy?
-Metabolic endocrine: mainly impacts liver (helps you get energy)
-Increases glucose utilization (more easily used to increase energy)
-Breaks down fat if not enough glucose (can lose weight when stressed)
-Breakdown protein in muscles (can lose muscle mass)
*If stress continues → can lose bone
-Increases vascular smooth muscle responsive to Epi/Norepi (sympathetic)
-Able to move nutrients around
-BP increases when stressed!
*Cortisol must shut down some systems to conserve energy for survival → Negative feedback to lower need for energy
-Anti-inflammatory: higher cortisol levels inhibit immune response
*Inflammation from injury → athlete gets cortisol shot to suppress it
-Inflammation = immune response trying to fix area
-Ex: During/after finals → sick b/c high cortisol levels suppress immune system
*Must survive until tomorrow, then you can treat sickness
-Lower immune system temporarily to save energy now
-Growth suppressed – high cortisol levels stunt growth
-If I can't feed myself now, don't need to feed a larger me
-Reproduction suppressed – high cortisol levels inhibit sexual drive
-Take a girl to a chick-flick!
-<u>Disorders</u>
-No cortisol → dead within days
-Needed to maintain specific levels to survive
-Adrenal insufficiency – too little cortisol
-Symptoms: Weak (not enough energy), decreased glucose levels, decreased BP
-AKA Addison's syndrome
-Cushing's syndrome – Too much cortisol (not from stress)
-Symptoms: decrease bone strength, increased glucose, high BP, decreased immune response, obesity (storing energy near vital areas (belly fat) → not used in metabolism)
*Can be diagnosed early wrong as diabetes
Somatic Growth → current growth (here and now), not future reproduction
-Somatic growth requires protein synthesis for all processes to work (cell division)
-Height – due to growth of bones (specific location)
-Adding new cells at epiphyseal plates (growth plates – where growth occurs)
-Steroids (sex endocrines) fuse plates during puberty → stop getting taller and fill out
*Careful when kids break bones – want in middle away from growth plates
-Adults don't have these issues – plates sealed
-Growth of other tissues based on cell proliferation via mitosis (same DNA – identical cells)
-Regulated by endocrines:

-**Growth Hormone (GH)**: released by GHRH, inhibited by Somatostatin
*Unique: E2 is main talking point as opposed to E3s for thyroid, adrenal
-See highest level during development (growing the most)
-Actions: Primarily to stimulate IGF-1 (E3) released from liver and bones
-Causes cell proliferation – sends message to liver to release IGF into blood, and to bone to stimulate plates directly
-Other option: GH impacts cell directly by stimulating muscle development
-To make a bigger you, need bigger muscles b/c bigger loads
*Different message sent – not making muscle cells but adding to inside of muscle cells
-Mobilizes nutrients to have energy for process (growth spurts)
-Periods of getting taller, then fill out (repeat)
-**TH:** needed for GH synthesis and effect
-Need right levels of T_3/T_4 to stimulate proper amount GH (amount of metabolism to provide energy for growth to occur)
-**Cortisol**: Can inhibit growth by inhibiting GH secretion in APG (similar to SS)
-If can't sustain self now, don't want to grow bigger
-Opposes the effects of GH in tissues
*Athletes don't realize that as cortisol levels increase (stress from poor stats) → decreases impacts of GH
-**Insulin**: Promotes growth
-Helps pack away nutrients you ingest to energize growth
-**Sex Steroids**: stimulate secretion of GH and IGF-1
-Historically: bigger male = reproductive advantage in finding a mate
heavier female = more success in carrying a baby
- Closure of epiphyseal plates → grow wide not tall
-Testosterone- anabolic → redundant (all sex endocrines build tissue)
**Unique: GH has many roles – impacts muscle development too
-Needs another way to shut down pathway besides negative feedback
-Somatostatin (E2) – acts directly to shut down pathway

<u>Regulation of Calcium</u> – need specific range → important for neurons, muscles, etc.
-3 systems involved in Calcium homeostasis
1. Bone – contains 99% of total
-Constant remodeling → bones are dynamic (NOT fixed)
*Energy taken away from area not used (trade-offs)
-If not moving, lose calcium – important to get old people moving (they have less energy/strength involved in bones)
2. Kidney – filters plasma to determine amount of calcium in urine
-Regulates calcium excretion (excrete more if high [calcium])
3. Gastrointestinal tract – site of calcium absorption from diet (regulates it)
*How do we impact all of these factors?

<u>2 Major Endocrines</u>
1. **Parathyroid hormone (PTH)** – Produced by parathyroid glands
-Glands have a receptor for calcium (chemosensory component) – checks levels
-decreased $[Ca^{2+}]$ in plasma → increased PTH (negative feedback)
-PTH acts to increase $[Ca^{2+}]$ in plasma by impacting 3 areas: ^^