

Exercise, Hormones & Function

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REMEMBER:

- Remember to complete this webinar by December 31st of *the same year in which you ordered it.*
- Certificates with *next year's* date may not be accepted by your credentialing organization.



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Understanding Hormonal Response: *It All Boils down to "Fight or Flight"*

- Hormonal response during and after exercise is to ensure that we have enough energy to survive: to fight or flee.



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What Are Hormones?

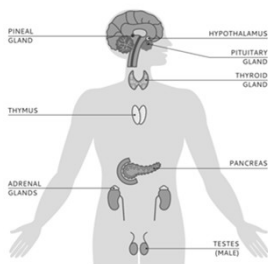
- The Endocrine System constantly monitors the body's internal environment.
- As homeostasis is disrupted, hormones are released to communicate a response.
- Hormones are chemical messengers.
 - Steroid vs Nonsteroid
- Released through negative feedback
 - Thermostat



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Major Endocrine Glands & Major Hormones

Gland & Location	Major Hormones	Primary Function
Hypothalamus (Brain)	Releasing hormones (e.g. GnRH) & dopamine	Tells the pituitary gland when to release its hormones.
Pituitary Gland (Base of skull)	Growth Hormone Luteinizing Hormone	Regulates growth, stress, and other endocrine glands.
Adrenals (Top of each kidney)	Cortisol Adrenaline, Epinephrine	Manages stress response, blood pressure, and metabolism.
Pancreas (Abdomen)	Insulin, Glucagon	Regulates blood sugar levels and energy storage.
Gonads (Testes/Ovaries)	Testosterone Estrogen & Progesterone	Regulate reproductive health and secondary sexual characteristics.



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Exercise & Hormonal Response:

The effect of hormones on exercise is often either misunderstood.... or ignored

- Exercise does not build muscle or burn fat: hormones do
- Hormonal balance prevents injury & improves immune function
- Hormones determine where and how you store body fat
- Hormones also offer significant psychological & cognitive benefits



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Major Roles of Hormones

1. Regulate Metabolism During Exercise
2. Regulate Fluid & Electrolytes During Exercise
3. Regulate Caloric Intake
4. Promote Growth & Repair



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Anabolic vs. Catabolic Hormones

- **Anabolic hormones** are responsible for muscle growth, bone density, and tissue repair. They take small molecules (like amino acids) and assemble them into complex structures (like muscle fibers).
- Examples:
 - Testosterone
 - Growth Hormone
 - Insulin
 - IGF-1
- **Catabolic hormones** are responsible for breaking down complex molecules (like body fat, glycogen, or muscle tissue) into smaller units to be burned for energy.
- Examples:
 - Cortisol
 - Glucagon
 - Adrenaline
 - Epinephrine

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Anabolic & Catabolic Response to Exercise

Different sides of the same coin

- High-intensity exercise is a catabolic event while it is happening, spiking cortisol to get energy.
- After exercise, the catabolic event creates a "stress signal" that triggers a massive anabolic response during recovery (spiking GH and Testosterone)
- This repairs the damage and makes the body stronger than before.



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Overview of the Major Metabolic Hormones

Hormones	Class	Key Functions
Growth Hormone (GH)	Anabolic	Stimulates cellular growth, reproduction, and regeneration; increases protein synthesis.
Testosterone	Anabolic	Promotes muscle protein synthesis, bone density, and secondary sexual characteristics.
Insulin	Anabolic	Facilitates glucose uptake by cells and promotes the storage of glycogen and lipids.
Insulin-like Growth Factor 1 (IGF-1)	Anabolic	Works with GH to stimulate growth in muscle, bone, and cartilage.
Estrogen (mixed anabolic/catabolic effects)	Anabolic	Influences bone and muscle maintenance.
Cortisol	Catabolic	Breaks down fats (and sometimes protein) to create glucose (gluconeogenesis) during stress or exercise.
Glucagon	Catabolic	Signals the liver to break down glycogen into glucose when blood sugar is low.
Adrenaline (Epinephrine)	Catabolic	Increases heart rate and breaks down glycogen and fat for immediate energy use.

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Regulating Carbohydrate Metabolism

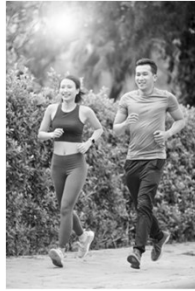


- As exercise intensity increases, so does the demand of glucose to muscles.
- Hormones increase plasma glucose concentrations:
 - Glucagon
 - Epinephrine
 - Norepinephrine
 - Cortisol
- Promote glycogenolysis & gluconeogenesis

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Regulating Fat Metabolism

- As exercise duration increases, there is a depletion of carbs and more reliance on fat for fuel.
- The rate of lipolysis is controlled by the hormones:
 - Decreased Insulin
 - Epinephrine
 - Norepinephrine
 - Cortisol
 - Growth Hormone



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Maintaining Blood Glucose



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Understanding What Insulin Does

- Produced by the pancreas, **insulin** is the body's primary **anabolic (building)** storage hormone.
- Allows cells to utilize blood glucose (insulin sensitivity)
- Regulates storage of glycogen
- Manages levels of sodium to maintain cardio function
- Increases amino acid uptake --- "pushing" amino acids into muscle cells
 - This is why post-exercise carbs are so vital!



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Insulin vs. Glucagon

Anabolic vs. Catabolic

Hormone	Trigger	Primary Action	State
Insulin	High Blood Sugar (Eating)	Stores energy; builds tissue.	Anabolic
Glucagon	Low Blood Sugar (Fasting)	Releases stored energy into blood.	Catabolic

- When blood sugar levels dip, the pancreas releases glucagon to pull sugar from the liver
- If blood sugar goes too low, glucagon increase gluconeogenesis.
- It also breaks down triglycerides into fatty acids for fuel –saving the glucose for the brain -- “ketosis”

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Understanding Cortisol

- Cortisol is produced in the adrenal glands in response to physical or psychological stress
- Also known as the “fight or flight” reaction
- During stressful periods the pituitary signals the adrenals to increase cortisol production
- As cortisol levels increase the entire body goes into “defense mode”
- Triggers the liver to release glucose into the blood stream
- Inhibits insulin production to keep blood sugar levels high
- Begins the process of breaking down protein for energy (gluconeogenesis)
- Maintains high levels of cardio function
- Slows down digestion
- Inhibits levels of estrogen and testosterone, reducing libido

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Lifestyle & Cortisol Levels

Factor	High Cortisol Trigger	Low/Balanced Cortisol Support
Exercise	Excessive duration (>90m) or insufficient rest.	Zone 2 “easy” cardio and adequate recovery.
Diet	Skipping meals or extreme low-carb.	Pre-workout carbs; Post-workout carbs and protein with anti-inflammatory fats.
Hydration	Chronic under-drinking or high caffeine.	Consistent water intake throughout the day.
Sleep	Chronic sleep deprivation or poor quality sleep	At least 6-8 hours of good quality (high REM) sleep per night.

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GH, Growth & Tissue Repair

GH stimulates growth during childhood, but maintains tissue throughout adulthood.

- **Bone Growth:** During childhood and adolescence, GH stimulates the production of cartilage cells at the ends of long bones, increasing height. In adults, it helps maintain bone density.
- **Muscle Protein Synthesis:** GH stimulates the uptake of amino acids and the synthesis of new proteins, which is essential for repairing muscle tissue after a workout or injury.
- **Organ Health:** It plays a role in maintaining the size and function of various internal organs.



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Power Training (PT) & Growth Hormone

- PT is a high-stress training modality, resulting in some soft-tissue breakdown.
- Growth hormone plays a significant role not only in building soft tissue but in repairing it too.
- Following PT the pituitary gland begins to secrete GH into the system; the higher the intensity, the larger the secretion.
- The connection between lactate threshold and GH secretion is because the lactatethreshold is reached with very high intensity training: >85% VO₂.
- Lower intensity, steady state training does not have the same effect on the pituitary gland.



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Understanding the Cori Cycle

Also called the "Lactic Acid Cycle"

- The Cori Cycle functions as a continuous loop between the skeletal muscles and the liver:
 - **In the Muscle:** During high-intensity (anaerobic) exercise, muscles demand energy faster than oxygen can be delivered. To meet this demand, they perform anaerobic glycolysis, breaking down glucose into **pyruvate**, which is then converted into **lactate**.
 - **Transportation:** The lactate is released from the muscle cells into the bloodstream, where it travels to the liver.
 - **In the Liver:** The liver takes up the lactate and performs **gluconeogenesis**. This process converts the lactate back into pyruvate and eventually back into **glucose**.
 - **Completion:** The "new" glucose is released back into the blood, where it can be used by the muscles again for energy.

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How HIT Triggers GH Production

High-intensity training (HIT) triggers a surge in anabolic hormones

- Here is the step-by-step breakdown of how that process works:
- **Metabolic Stress and Lactate Accumulation**
 - One of the primary triggers for **Growth Hormone (GH)** release is the accumulation of metabolic byproducts, specifically **lactic acid** and hydrogen ions.
- **The Mechanism**
 - During high-intensity bursts, the body relies on anaerobic glycolysis. This creates a drop in blood pH (increased acidity).
- **The Response**
 - This acidic environment signals the pituitary gland to secrete GH. GH helps mobilize free fatty acids for energy, which spares glucose for the brain and nervous system during the "fight or flight" state of the workout.

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The Intensity Threshold

- During high intensity exercise, 70-85% of VO₂ :
- Growth hormone and testosterone spike
- Insulin Sensitivity Increases
- Cortisol spikes
- What about estrogen?
 - During high intensity exercise, reproductive-hormone signaling is deprioritized as the HPA axis takes over: the hypothalamus signals the pituitary, which signals the adrenal glands to produce more cortisol



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GH & "Fuel Switching"

- GH is a major regulator of how your body uses energy. It essentially tells the body to save sugar and burn fat.
- **Lipolysis (Fat Burning):** GH signals the body to break down triglycerides (stored fat) into free fatty acids used for energy.
- **Glucose Preservation:** It reduces the uptake of glucose by muscles and fat cells, keeping blood sugar levels stable during fasting or intense physical exertion.
- **Protein Sparing:** By using fat for fuel, GH prevents the body from breaking down muscle tissue for energy during "starvation" or high-stress states.



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Fluid & Electrolyte Balance

- Prolonged exercise reduced plasma volume due to water loss.
- This leads to increased blood pressure and strain on the heart to deliver blood to muscles.
- Antidiuretic Hormone (ADH) instructs kidneys to reabsorb water
- Aldosterone assists in water retention by reabsorbing sodium and excreting potassium.
- Heavy sweating activates both systems at once — sodium/water loss triggers aldosterone, while rising blood concentration triggers ADH. This is the hormonal reason under-hydrated or heavily salt-depleted clients cramp, fatigue early, or feel dizzy.
- Recommendations:
 - Exercise duration <60 minutes: water is generally sufficient
 - Exercise of longer duration and/or higher sweat rate might need electrolytes, such as sodium and potassium.

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Regulating Caloric Intake

- Food intake is primarily controlled from the brain and hypothalamus with input from hormones from the gut and fat cells.
- Hormones can suppress appetite or stimulate it.
- GLP-1 released from the intestines, travels to the brain to suppress hunger.
- Leptin is secreted by fat cells and acts on receptors in the hypothalamus to decrease hunger.
 - Higher fat cells means higher levels of leptin, but many obese suffer from leptin resistance.
- Ghrelin is secreted primarily from the stomach and travels through the blood brain barrier to act on the hunger areas in the hypothalamus.

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Anabolic Growth & Development

Hormone	What It Does	Why It's Released
Testosterone	Drives muscle protein synthesis, bone density, and secondary sex characteristics	Released in response to mechanical tension (heavy lifting, compound lifts) and neural signaling through the HPG axis.
Growth Hormone	Stimulates tissue repair, mobilizes fat for fuel, and preserves glucose and muscle protein	Released from the pituitary during high intensity exercise, deep sleep, and dips in blood glucose.
IGF-1	Does the actual cell-level building. Drives protein synthesis, bone growth, and cell proliferation.	Released by the liver in direct response to GH signaling.
Estrogen	Supports muscle mass, bone density, and connective tissue health.	Released from the ovaries (in men, via conversion from testosterone).

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Understanding What Testosterone Does

- **Musculoskeletal System:** It is a major driver of muscle protein synthesis, leading to increased muscle mass. It also improves bone density by stimulating the production of bone-forming cells.
- **Libido:** It is the primary hormone responsible for sexual desire.
- **Reproductive Health:** It is essential for the production of sperm and the development of reproductive tissues like the testes and prostate.
- **Secondary Sex Characteristics:** During puberty, it triggers the deepening of the voice, the growth of facial and body hair, and the broadening of the shoulders.
- **Fat Distribution:** It helps regulate how the body stores fat; lower levels are often associated with increased abdominal fat.
- **Mood Regulation:** Balanced levels are linked to a sense of well-being and confidence.



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Understanding “Free” Testosterone

The 2% of a man's testosterone not bound to specific proteins

- What it does
 - Affects muscle growth, bone density and fat distribution
 - Improves mood, energy, libido
- What if its too low
 - Fat increases, muscle decreases
 - Mood, energy & libido decline
- How to increase it
 - Healthy diet, esp protein & healthy fats
 - Adequate, good quality sleep
 - Stress management
- Free testosterone & cortisol are antagonists



Free testosterone easily enters cells & exerts anabolic effects immediately

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Power Training (PT) & Testosterone

Strength training & PT can increase testosterone levels

- To speed the body's reparation process, PT stimulates the pituitary gland to produce more GH.
- Simultaneously, the pituitary also increases production of luteinizing hormone (LH) - this hormone triggers the testes to produce more testosterone.
- PT and strength training with short rests seems to result in greater LH production, and thus a greater testosterone production.
- The greater the intensity and workload of PT the greater the elevation of testosterone.



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Variables Affecting Testosterone & GH Production

Variable	Optimal for Testosterone	Why?
Intensity	High (Heavy Loads/Sprints)	Forces the recruitment of Type II fibers.
Rest Periods	Moderate (90–120 seconds)	Balances the need for power with metabolic stress.
Volume	Moderate to High	Multiple sets provide a cumulative stimulus.
Exercise Choice	Compound Movements	Engages the largest possible muscle groups.

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Testosterone Levels & Older Men

- Testosterone is measured in “nanograms per deciliter” (ng/dl)
- “Normal” testosterone is between 300 -1100 ng/dl
- Starting at age 30 most men’s testosterone declines by about 1% per year
- Men who are inactive or heavy or very stressed tend to see more rapid declines and have overall lower levels of testosterone
- Low testosterone is associated with:
 - Increased body fat (especially the chest)
 - Decreased muscle mass
 - Poor energy
 - Poor sleep
 - Mood swings
 - Hot flashes
 - Diminished libido
 - Difficulty achieving/maintaining erections
 - Difficult maintaining/increasing muscle mass



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How HIT Triggers Testosterone Production

Testosterone response is directly proportional to the amount of muscle tissue activated.

- **The Trigger:** Compound, multi-joint movements (like squats, deadlifts, or heavy presses) require the nervous system to recruit **high-threshold motor units**.
- **The Result:** The greater the volume of muscle worked at high intensity, the more significant the acute rise in testosterone. This is why a heavy leg day typically produces a larger hormonal spike than an isolated arm workout.
- **Neurological Stimulation:** Intense training heavily taxes the Central Nervous System (CNS).
- **The Trigger:** The “fight-or-flight” response during a near-maximal sprint or lift activates the hypothalamic-pituitary-gonadal (HPG) axis.
- **The Result:** The hypothalamus releases Gonadotropin-Releasing Hormone (GnRH), which signals the pituitary gland to release Luteinizing Hormone (LH). LH then travels to the Leydig cells in the testes (or ovaries/adrenal glands in women) to stimulate the production of testosterone.

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Exercise Variables & Testosterone

- What to Include:
 - Heavy Resistance Training
 - Compound, primal exercises & explosive movements
 - 3-5 sets of 5-8 reps each
 - 80-95% of the 1 RM
 - Short rest periods: 30 -90 seconds
 - No more than 60 minutes per session
 - 2-4 times per week
 - HIIT
 - Sprinting
 - Tabata Intervals
- What to Avoid
 - Excessive endurance training
 - Long distance runs or cycling
 - Insufficient rest
 - Less than 8 hours of sleep, or less than 48-72 hours between sessions
 - Insufficient caloric intake
 - Any of the above will keep cortisol levels elevated

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Understanding Insulin-like Growth Factor (IGF-1)

Bone Growth & Cell Proliferation

- IGF-1 works with parathyroid hormone and Vitamin D to regulate bone metabolism. It stimulates **osteoblasts** (cells that form bone), which helps maintain bone density and strength as you age.
- Unlike many other hormones, IGF-1 doesn't just make cells bigger; it encourages them to divide and multiply (**hyperplasia**). It also acts to prevent healthy cells from dying prematurely.



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Insulin-like Growth Factor (IGF-1)

Muscle and Tissue Repair

- **Anabolic Effects:**IGF-1 builds things up. In adults, its primary job is maintaining and repairing muscle, cartilage, and bone.
- **Hypertrophy:** It stimulates the increase in the size of muscle cells.
- **Satellite Cell Activation:** It "wakes up" specialized stem cells (satellite cells) to repair damaged muscle fibers after a strenuous workout.



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Insulin-like Growth Factor (IGF-1)

Insulin-like Metabolic Effects

- As the name suggests, IGF-1 has a structure very similar to insulin.
- It can bind to insulin receptors (though less effectively than insulin itself).
- It helps lower blood sugar by encouraging muscles to take up glucose from the bloodstream for fuel.



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IGF-1: A Delicate Balancing Act

"More" is not always "better"

- **Too Little:** Low levels of IGF-1 can lead to stunted growth in children or poor muscle recovery, brittle bones, and low energy in adults.
- **Too Much:** Because IGF-1 is so good at making cells multiply, chronically high levels are sometimes linked to an increased risk of certain cancers, as it may encourage the growth of abnormal cells just as much as healthy ones.



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Variables Affecting IGF-1

Factor	Effect on IGF-1	Result
Heavy Lifting	Increase	Localized IGF-1 release in the muscle leads to strength gains.
Deep Sleep	Increase	High GH pulses at night lead to higher morning IGF-1 for recovery.
Aging	Decrease	Lower levels contribute to muscle loss (sarcopenia) and thinning skin.
High Protein Intake	Increase	Amino acids (especially leucine) signal the liver to produce more IGF-1.

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GH & the IGF-1 Connection

- Many of the growth-promoting effects of GH aren't caused by the hormone itself. Instead, GH travels to the liver, where it triggers the release of Insulin-like Growth Factor-1 (IGF-1).
- IGF-1 is the actual "messenger" that tells individual cells in the muscles, bones, and tendons to multiply and grow.



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Estrogen & Exercise Capacity

Estrogen levels are typically highest during or around ovulation, affecting several variables

- Muscle Strength & Repair
 - High estrogen yields better performance
- Cardiovascular Endurance
 - Estrogen peaks (around and during ovulation) increases cardio capacity
- Injury Risk
 - Strengthens bones and muscles but increases connective tissue laxity, making injuries more likely
- Post-menopausal Effects
 - Declining estrogen levels lead to rapid declines in strength and bone density



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Exercise, Estrogen & Progesterone

Estrogen plays a greater role in maintaining musculoskeletal health

- Estrogen
 - Estrogen exhibits "anabolic properties"
 - Maintains muscle mass & strength
 - Maintains bone density
 - Prevents accumulation of visceral fat
- Progesterone
 - Progesterone exhibits "anti-anabolic" effects
 - Minimal influence on maintaining muscular strength, muscle mass & bone density
 - Increases BMR



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FDA Lifts Warnings for Hormone Replacement Therapy (HRT)

Washington Post, 11-10-25

- FDA has removed the “black box” warning from HRT labeling.
- HRT for *newly menopausal* women has multiple benefits including managing menopausal symptoms including “brain fog.”
- “Hormone Replacement Therapy (HRT) may improve the health outcomes of women more than any other intervention.....with the exception of antibiotics and vaccines.”
 - FDA Commissioner Marty Makary, November 10, 2025



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Estrogen, Progesterone & Older Women

- In the late 1990's & early 2000's, the Women's Health Initiative Memory Study “found” that menopausal HRT increased risk of dementia
 - Also heart disease and breast cancer
- Subsequent carefully designed clinical trials have found that HRT initiated close to the onset of menopause presented no cognitive risk and that....
- ... combining estrogen with progesterone also mitigated the risk of certain cancers



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Growth Hormone Replacement Therapy

Usual dose is subcutaneous injections 4-6 nights per week before bed

- Benefits
 - Increased lean body mass
 - Improved definition
 - Increased energy & endurance
 - Increased bone mass
 - Improved recovery
- Risks
 - Edema
 - Insulin resistance
 - Joint pain
 - Cardiovascular risks
 - Risks are dose-dependent
- Monthly cost \$500 - \$1000



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Growth Hormone: Dosing & Frequency

- Subcutaneous Injections
 - The gold standard: typically self-administered abdominal injection 4-6 days per week
- Transdermal (topical) creams
 - Compounded creams rubbed on targeted body parts on a daily or near-daily basis
- Cycling protocols
 - Often administered in 6-12 week cycles followed by a resting period
- Cost: \$500-\$750 per month



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Testosterone Replacement Therapy Potential Benefits of Testosterone Replacement Therapy

- Low T-levels are associated with fat gain, muscle loss, inhibition of libido, mood changes & lower energy levels.
- With regular blood & hormonal checks, many men will experience:
 - Increased strength & muscularity
 - Improved body fat management
 - Improved mood & quality of life
 - Increased energy
 - Increased libido
 - Improved self-image
 - Reduced aches & pains



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Potential Risks of Testosterone Replacement Therapy (TRT)

- Potential risks of TRT:
 - Increase in red blood cells that may increase risk of heart attack or stroke
 - Sleep apnea
 - Acne
 - Enlargement of the prostate: BPH (Benign Prostate Hyperplasia)
 - May result in testicular shrinkage
 - May increase growth of established prostate cancer
 - Increased aggression, risk-taking behaviors
- Risks increase when testosterone is obtained on the black market OR when the testosterone comes from an unknown source
- TRT is generally not covered by insurance or Medicare unless testosterone levels are beneath 300ng/dl
- Some older men with low testosterone levels have levels below 100 ng/dl
- Comparison: Boys from infancy to age 11/12: 60 ng/dl

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Testosterone: Dosing & Frequency

- Subcutaneous Injections
 - The gold standard: typically self-administered abdominal injection once a week
- Human Chorionic Gonadotropin (HCG) Injections (for men)
 - HCG is often administered during TRT to ensure the man's testicles keep producing testosterone, especially when/if TRT ends.
- Transdermal (topical) creams
 - Compounded creams rubbed on targeted body parts on a daily or near-daily basis
 - Effective for keeping T levels consistent
- Cost: \$250 - \$400 per month



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Testosterone Supplementation... for Women?

- Critical to a woman's health, testosterone deficiency often occurs during menopause & after menopause. Clinically-supervised supplementation can:
 - Increase muscle mass & bone mass
 - Reduce visceral fat
 - Improve libido & sexual satisfaction
 - Enhance focus & mental acuity
 - Improve mood
- Insurance companies typically do not cover TRT for women
- Goal is to restore the testosterone to the level of a healthy 25-30 year old.



An adult woman's typical testosterone level is 15-50 ng/dl; an adult man's is 400-1000 ng/dl.

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The End: Thanks for Watching!

Questions? Comments?

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