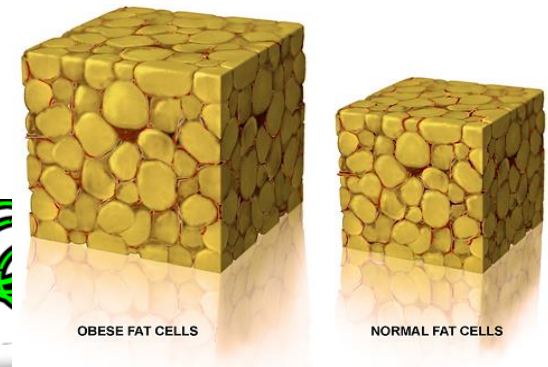


Metabolism and Fat

Update – Science to Application.



FAT
METABOLISM



Developed by:

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Introduction ...



Metabolism – What do we Want?

- Increased rates – increase caloric expenditure
- Increased lean body mass
- Greater fat utilization
- Less abdominal fat
- Weight loss – improved body composition
- Aesthetics – health – functionality – vitality – independence.



Fat-to-Fit
Flab-to-Fab

Identify primary influencers of these outcomes?

- Nutrition?
- Exercise, activity and/or movement?
- Stress?
- Age (+ hormonal changes), gender?
- Genetic predisposition?
- Socio-economic, geographical, environmental factors?

Your course was plotted many years ago – how realistic is it to reverse changes?



Metabolism ... RMR



What We Cannot Control (examples)

- **Age-related Reductions in RMR:**
 - Decreases ~ 2% / decade.
 - 25-30 kcal per day (5-6 minute walk) = 2½-3 lbs./year (1.1-1.4 Kg/year).
 - Causes – biological (sarcopenia), hormonal changes; behavioral (activity, diet) and socio-cultural (societal norms, cohort influences).
- **Genetics and Epigenetics:**
 - Approximately 100 different genes identified related to obesity.
 - FTO gene (key obesity gene) can alter RMR by up to 160 kcal / day.
 - Gene expression is influenced by our environment (diet, etc.) – can alter RMR by 5% per day.
- **Adaptive Thermogenesis (set-point theory):**
 - With weight loss, brain senses starvation = reduced RMR to conserve energy.



Metabolism ... RMR



What We Cannot Control (examples)

- **Hormones:**
 - Estrogen play a big role in regulating fuel utilization and storage.

	Females	Males
Rested state	Greater fat utilization, but influenced by diet* and conditioning status.	Greater glucose utilization, but influenced by diet* and conditioning status.
Post-prandial	Women take up and store fat faster than men, but oxidize more glucose immediately relative to men	Following high-carb diets (70%), men = increased glycogen, but not women (immediate glucose utilization v. stored).
During exercise	Higher proportion of fat burned at any given intensity – spares glycogen.	Higher glycolytic capacity for anaerobic work, greater lactate accumulation = longer recoveries.
Post-exercise	EPOC + recovery: Women utilize increased proportion of carbohydrates.	EPOC + recovery: Men utilize increased proportions of fat.

- Female's menstrual cycle alters RMR up to 100 kcal / day due to core temperature fluctuations (follicular phase before ovulation = lower kcal v. luteal phase = higher kcal).

What We Can Control (examples)

A dark blue hexagon with a slight 3D effect, containing the text "RMR Ideas" in white.

RMR Ideas



Dieting Realities

- Throughout our evolution (Paleolithic, Mesolithic, today), human have eaten many different foods across diverse geographical regions where we ate very different foods.

Humans have survived and thrived!

What diet is best for weight loss*?

- **Study:** Meta-analysis of 49 different diets (low-carb – Atkins, South Beach to low-fat – Ornish, Pritikin) v. blended diets (Weight Watchers, Jenny Craig).
- **Conclusions:**
 - No long-term weight differences between low-fat and low-carb, but poorer adherence with lower carbohydrates.
 - Blended diets: slightly less weight loss, but demonstrate better adherence.
 - Starvation diets tend to slow weight loss – why? (car analogy).



Diet and Weight Loss ...



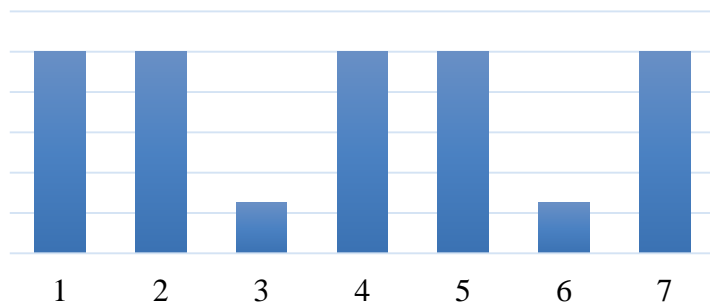
Intermittent Fasting (variations)

Include variations like 16:8 v. every-other-day (Varaday) v. Mosley (5:2).

- **Research:** Mosley/Varaday:
 - Improved insulin sensitivity, reduced memory loss, better cancer management, successful weight loss, improved adherence.

5:2

Caloric Intake



5 days = more mindful eating + 2 days = strategic, non-consecutive fasting (25% of normal intake).

Consideration	Action
Fasting Kcal Range	Men: ~ 600-700 kcal; Women: ~ 500-600 kcal
Timing	<ul style="list-style-type: none">• Breakfast: 120-150 kcal (20-25g CHO + 7-8 g Pro (3:1 ratio)).• 2-3 meals evenly spaced (high protein/fat with 0 carbs – satiety)
Fasting Day Exercise	Tapered down or none v. the non-fasted days.

Diet and Weight Loss ...



Intermittent Fasting (variations)

Let's do the math:

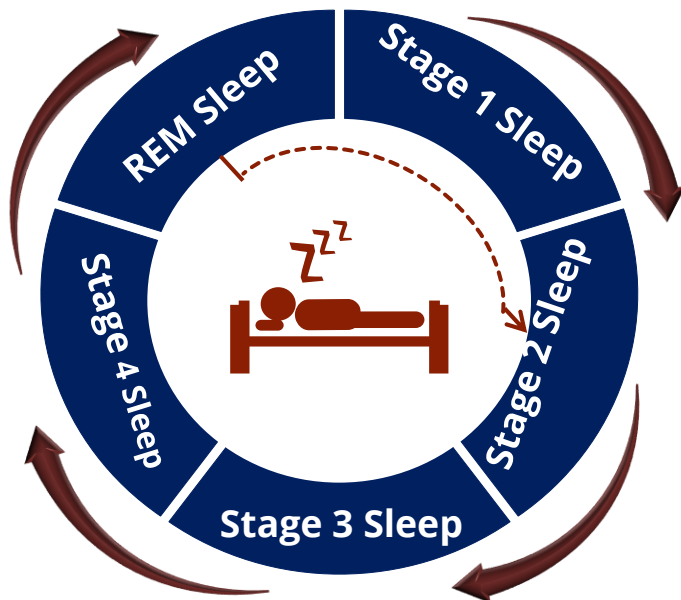
	Traditional Diet	Intermittent Fasting
Example	2,400 kcal per day	2,400 kcal per day
Plan	Daily reduction (700 kcal/day)	2 days / week = modified fast
Plan	1,600 kcal per day (planned)	5 days / week = mindful eating
Numbers	7 days x 700 = 4,900 kcal	5 days x 200 kcal = 1,000 kcal 2 days = 600 kcal (4,600 kcal total)
Loss	1.4 lbs. / 0.63 Kg / week	1.3 lbs. / 0.6 Kg / week
	Restrictions?	Lifestyle benefits?

Respect Hunger – Control Appetite



Metabolism ... RMR

- Sleep:
 - Can slow RMR by 5-20%.
 - How do you recover from sleep debt?
 - 20-24 min power naps = 1 hour debt, but done within the subsequent 12-24 hours.



Sleep – 2 basic stages:

- Rapid eye movement (REM) sleep (dreams)
- Non-rapid eye movement (NREM) sleep (stages 1-4) with each stage lasting 5-15 minutes (quiet sleep).



Metabolism ... RMR

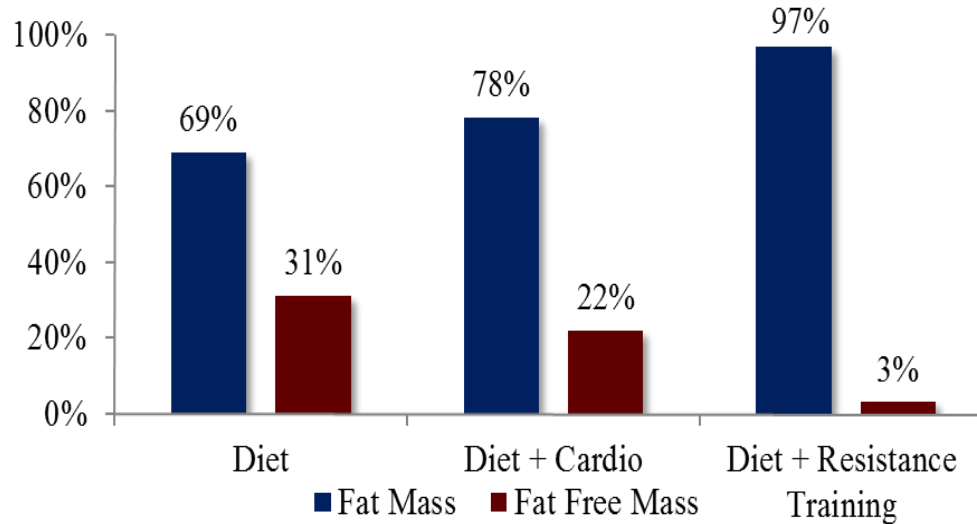


Build Lean Mass	EPOC – minimal	Diet / Starvation – Stress Response
<ul style="list-style-type: none">• Peak muscle mass = ages 28-32 (0.4% loss per year) – up to 0.8% loss per year).• Adulthood average gain = ~ 2-4 lbs.• Boosts RMR 7-8% (metabolic changes) = 90-110 kcal per day = 9-11 lbs. (~4.5Kg)/year.	<ul style="list-style-type: none">• Averages only 2-3 lbs. (1.1 Kg) / year for average adult.	<ul style="list-style-type: none">• Think biological design – feast-or-famine (survival).• Temporary RMR suppression up to 20%.• 240-300 kcal/day = ~ 25-31 lbs. 11.4-14 Kg) / year. <p>Respect hunger – control appetite.</p>

Fluid – why?

- Feeling full + avoid physiological slow down with dehydrated calls.
- How much fluid do you drink daily – is it enough?
 - Minimum = # fluid ounces = half body weight (lbs.) (e.g., 75 oz. @ 150lbs.)
 - Minimum = **30-40 mL / Kg of body weight.**
 - Does not include additional sweat rates (min of 475 mL / hour exercise).
- Fluid and flexibility – myofascial tissue?

Metabolism ... RMR



New Protein Considerations:

- Already established = Adult RDA + position statements for endurance and resistance-trained individuals.

Weight Loss	Muscle Loss with Aging (Sarcopenia)
<p>Higher protein intakes $> 1.25\text{g/Kg BW}$ (0.57g/lb.) = minimal LBM losses v. current RDA value</p> <p>Current RDA = 0.8g/Kg (0.36g/lb.)</p>	<p>Aging = lower sensitivity to protein's MPS effect.</p> <ul style="list-style-type: none">• MPS: 20g in younger adults = 35-40g in older adults (> 65 years).• Should protein RDA increase to $1.0\text{-}1.5\text{g/Kg}$ ($0.45\text{-}0.68\text{g/lb.}$) v. current RDA?

Metabolism ... TEPA



Activity, Exercise and Movement:

- Seek to lose/maintain weight = dieting, poor experiences and failure!!
 - 2,000 kcal per week needed for effective weight loss..

Measure	Male: 195.5 lbs. (88.9 Kg)	Female: 166.2 lbs. (75.5 Kg)
<u>Cardio Program:</u>	1,616 kcal	1,373 kcal
• 4 x 30 min @ 5 mph	(10.4 % of caloric intake total)	(11.0 % of caloric intake total)
Min needed to target 2,000 kcal:	Additional 28 minutes a week	Additional 55 minutes a week
<u>Weight Training:</u>	1,245 kcal	1,057 kcal
• 4 x 60 min (1-to-2 work-to-recovery ratio)	(8.0 % of caloric intake total)	(8.5 % of caloric intake total)
Min needed to target 2,000 kcal:	Additional 145 minutes a week	Additional 214 minutes a week
<u>Metabolic Resistance Circuit:</u>	1,270 kcal	1,078 kcal
• Integrated or whole body	(8.2 % of total caloric intake)	(8.7 % of total caloric intake)
• 3 x 40 min higher-intensity (4-to-1 work-to-recovery ratio)		
Min needed to target 2,000 kcal:	Additional 69 minutes a week	Additional 103 minutes a week

Metabolism ... TEPA



Activity, Exercise and Movement:

- Seek to lose/maintain weight: Shift focus to NEAT – more hours/day – simple, manageable opportunities.

Sleep	Exercise	Balance?
49-56 hours / week	3-5 hours / week	107-116 hours / week ??

Measured Parameter	Male: 195.5 lbs.	Female: 166.2 lbs.
Kcal Sitting (light office work) – 1½ MET	2.3 kcal / minute	1.98 kcal / minute
Kcal Standing (light office work) – 2.0 MET	3.2 kcal / minute	2.77 kcal / minute
Adding 2 more hours of standing / day	~ 108 kcal more/day	~ 95 kcal more/day
Weight change in year: (50-wk work year)	~ 11.3 lbs. (5.1 Kg)	~ 9.9 lbs. (4.5 Kg)

SLOTH: Sleep, Leisure, Occupation, Transportation, Household



- 10 lbs. x 3,500 kcal = 35,000 kcal.
- At 300 kcal / session = 117 additional exercise sessions (2.2x/week).

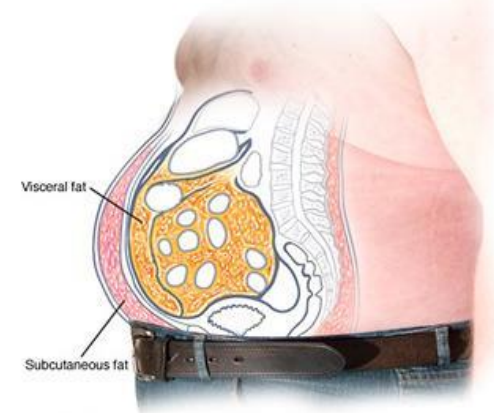
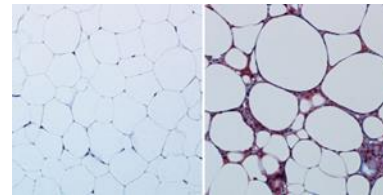


Fat Storage and Utilization ...



Fat Layers – many locations for fat in the body

- Visceral or belly (larger amounts).
- Subcutaneous – deep or superficial (larger amounts).
- Intramuscular, Cardiac and Intrahepatic (small amounts)
- Retro peritoneal (back – very small amounts).



Role of the Fat Cell (adipocyte):

- Excess energy storage (survival – feast-or-famine).
 - Source of energy-rich fatty acids during negative energy balance and v.v.
- Insulation and protection.
- Secretory (proteins and hormones – adipokines like leptin and adiponectin).
- Secondary roles in immunity, inflammation, vasculogenesis, matrix remodeling.

Fat Storage and Utilization ...



During lifecycle, fat cells increase in:

- Size = hypertrophy.
- Number = hyperplasia (adipogenesis).
- Normal adult = ~ 30-50 billion fat cells (remains somewhat constant).
 - Obese adults (with child-onset obesity) = ~ 60-100 billion fat cells.
 - Reducing/maintaining weight loss is more difficult with more fat cells.
 - **Theory:** Every fat cell needs to maintain a nominal amount of fat – fat cells will resist weight reduction.

Hyperplasia (Adipogenesis)	Hypertrophic Obesity (creeping / adult-onset)
<ul style="list-style-type: none">• Birth to age 2 (3-to-4 fold increase).• Adolescent growth spurt.• Morbid obesity (BMI > 40 kg/m²) – cell hypoxia.• Possible – 3rd trimester of pregnancy with excessive weight gain.• Research supporting sub-cutaneous fat cell number increase in legs (females) during adulthood.	<ul style="list-style-type: none">• Predominantly between 25-45 (slowing metabolism + lifestyle changes).• Men:<ul style="list-style-type: none">○ Age 18-44 = ~ 1.25 lbs. (0.57 Kg) / year.○ Age 45-65 = ~ 0.81 lbs. (0.37 Kg) / year.• Women:<ul style="list-style-type: none">○ Age 18-44 = ~ 0.97 lbs. (0.44 Kg) / year.○ Age 45-65 = ~ 1.14 lbs. (0.52 Kg) / year.

Fat Storage and Utilization ...



Gender Differences

	Males	Females
Primary Deposition	More visceral fat	More subcutaneous fat
Shape	Apple or android	Pear or gynoid
Insulin Sensitivity	Lower insulin sensitivity	Greater insulin sensitivity (declines after menopause – can improve with HRT (oral contraceptives can lower insulin sensitivity when matched for BMI, body composition and activity).

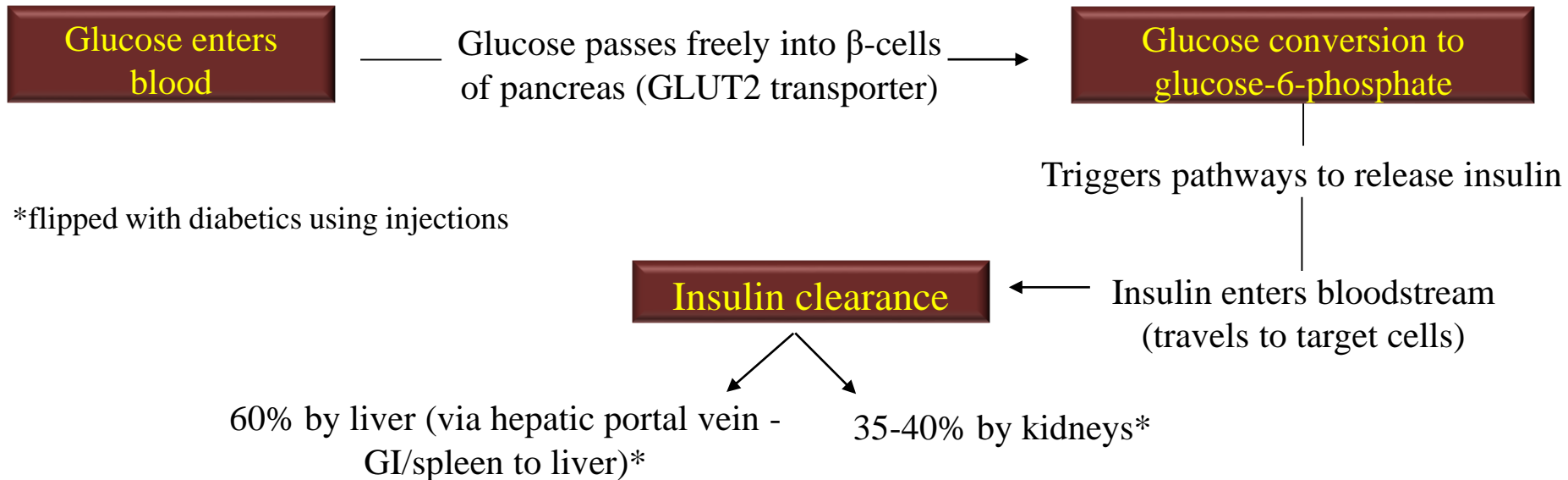
Characteristic	Visceral	Subcutaneous
Deposition	50% when younger (more when older).	50% when younger (less when older).
Blood Supply	Richer.	Poorer.
Hormone Sensitivity	Visceral fat is more sensitive to adrenal hormones (CATS, cortisol). Less receptive to insulin.	Less receptive to adrenal hormones (CATS, cortisol). More receptive to insulin.
Other Concerns	More active in producing inflammatory cytokines.	

Fat Storage and Utilization ...



Glucose, Fat, Hormones and Liver

- Liver and pancreas = primary regulatory organs for blood glucose.



- Insulin promotes synthesis and storage within adipocytes + inhibits lipolysis (inhibits hormone-sensitive lipase – HSL).
 - Activates GLUT4 transporter for glucose uptake into cells.
 - Glucose can act as precursor to glycerol and FFA = triglycerides.

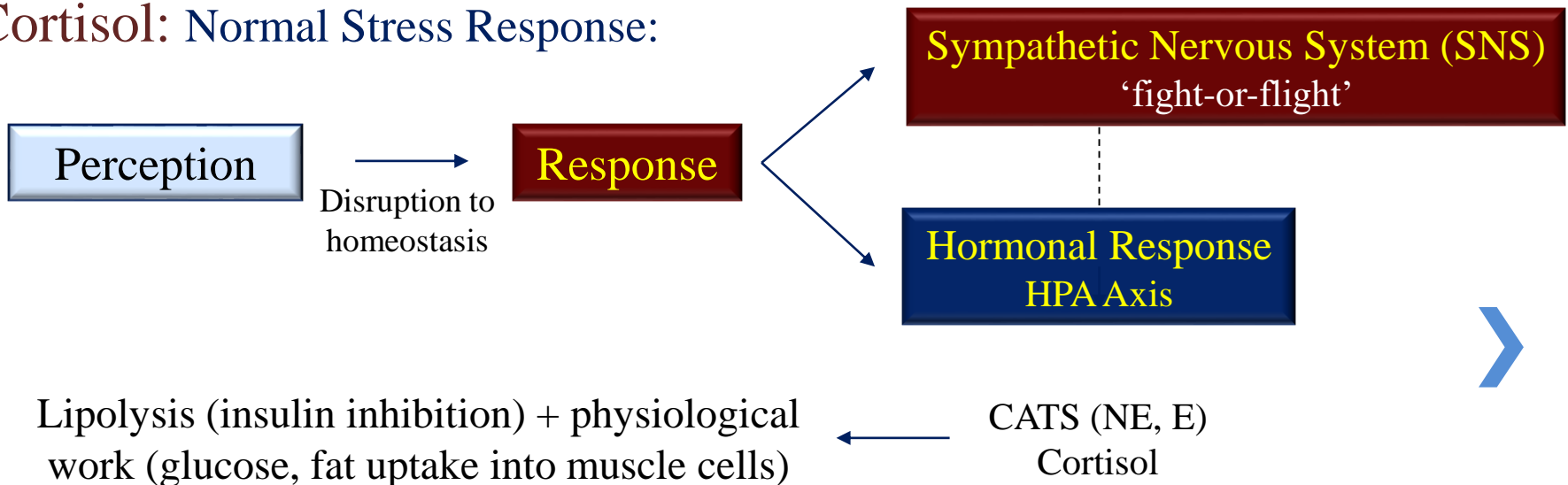
Fat Storage and Utilization ...

Glucose, Fat, Hormones and Liver

Insulin: Resistance = increased lipolysis = increase lipids in circulation = increased uptake into liver.

- Accumulation of fat in liver cells = **non-alcoholic fatty liver disease (NAFLD)**.
- Visceral fat passing through liver also decreases liver's insulin sensitivity – alters glucose homeostasis.

Cortisol: Normal Stress Response:



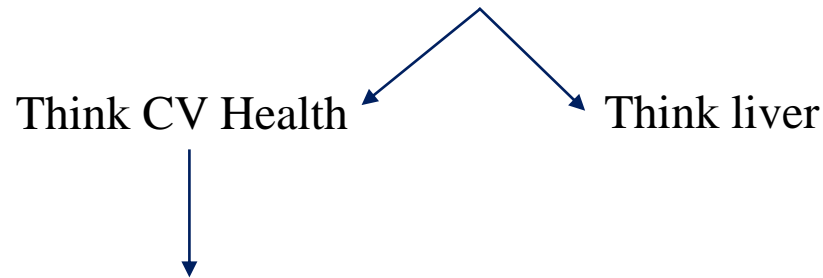
Fat Storage and Utilization ...



Glucose, Fat, Hormones and Liver

Sustained (psycho-emotional) Stress Response:

Cortisol → Elevated TGs, glucose in blood, but **NO** physiological work, therefore reduced glucose, fat uptake into muscle cells.



Characteristic	Visceral
Hormone Sensitivity	Visceral fat is more sensitive to cortisol (greater deposition).
Other Concerns	More active in producing inflammatory cytokines.



Fat Storage and Utilization ...



Hormones and Fat Utilization

	Females	Males
Overall muscle mass	Less	More
Type II (anaerobic)	3½-5%, up to 30% less	
Muscle Energy Stores	Larger intramuscular TGs.	Larger glycogen stores.
	Estrogen delays speed of contractile tissue – favors more type I fibers.	

Muscles have estrogen receptors – muscles undergo beneficial adaptations with aerobic training in both genders.

Endurance-trained men have 3-5x more estrogen receptors in muscles v. sedentary men – enables greater fat uptake into cells.

Intramuscular TGs are more accessible in females:

- *Men:* Posses fewer, but larger lipid droplets and fewer **perilipins** (proteins bound to outside of lipid droplet – hydrolyzes TGs and helps transport FFAs into mitochondria).
- *Women:* More numerous, smaller lipid droplets and more **perilipins** = higher surface area-to-volume ratio = greater break down of TGs to mitochondria.

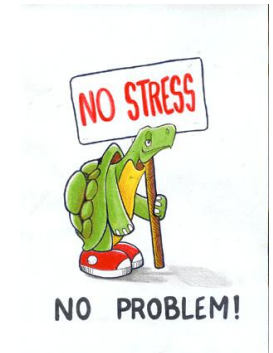


Fat and Metabolism ...



Takeaways:

- **Insulin-cortisol balance:**
 - Insulin = liver, blood glucose, and homeostasis hormone.
 - Cortisol = stress hormone.
- **Control insulin levels with:**
 - Reduced glycemic loads (more protein, fat and fiber).
 - Sustained insulin sensitivity (i.e. activity).
- **Control cortisol levels with:**
 - Identifying, avoiding and managing stress.
 - Avoiding carbohydrate restriction = reduced liver stores – blood sugar effect.
- **Activity:**
 - Catecholamine release – stimulates visceral fat lipolysis.
- **Dietary:**
 - Low glycemic load meals – allow high glycemic only during immediately pre-, during exercise and post-exercise periods).
 - Respect hunger and control appetite.



Thank You..!!

For Your Commitment to Excellence

Questions .. ??



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