

## Sports Supplements 2010 (and some of 2011!)

A Year (and a bit) in Review

## Sports Nutrition 2010-11

- Looking at supplements with new research in 2010
- Examining a cross-section of evidence/literature gives little relevant information
- Any study must be put into context of other research!
- Where we were / Where we are now!
- NOT an exhaustive (or stimulating) review!
- Competition – pick the worst segue!

## Science Lesson 1

- One study is never enough!
- Things change as studies improve
  - Duplication of results
  - Better quality
  - More relevant populations
  - More relevant measures of improvement

## Going to the source!

- Studies will usually put their own research into context around other studies
- They usually discuss the strengths and weaknesses of those studies
- They usually critique their own work
- Will suggest future studies

## Are supplements necessary?



AIS website: [www.ais.org.au](http://www.ais.org.au)

## Doping – Your Urine, Your Fault

- It doesn't really matter how it got there!
- 2000-2001 IOC tested 634 products from 13 countries
  - 15% positive
- 2007 (WADA Lab) tested 58 supplements from USA
  - 24% illegal steroids and 11% stimulants
- 2008 (same lab) 152 products purchased in UK
  - 10% contaminated steroids/stimulants
- This is a real risk and should be considered when recommending to professional/tested athletes!

## Where We Were: Carbohydrates

- Up to 8-10 grams/day of carbohydrate
- Easy to cherry pick low carb studies – not conclusive
- Glycaemic Index/Load vs Simple and Complex Carbs
- Carbs 4-6 hrs pre to restore muscle glycogen
- 30-60 mins to maintain blood glucose (only if activity/performance demands it!)
- CHO oxidation differ based on the type of carbohydrate - different transporters
  - glucose and sucrose or maltodextrin and fructose

## Acute CHO Recommendations

- Optimal daily muscle glycogen storage
  - 7–12 g/kg body mass/day
- Rapid postexercise recovery of muscle glycogen
  - 1–1.2 g/kg immediately after exercise; repeated each hour until meal schedule is resumed
  - Consuming carbohydrate as a series of small snacks every 15–60 min in early recovery phase may be advantageous
- Pre-event meal to increase carbohydrate availability before prolonged exercise session
  - 1–4 g/kg eaten 1–4 h before exercise
- Moderate-intensity or intermittent exercise of >1 h
  - Exercise of 1 h: small amounts of carbohydrate (including even mouth rinsing with a carbohydrate drink)
  - Exercise of >90 min: 0.5–1.0 g/kg/h (30–60 g/h)
  - Exercise of >4 h: maximal rates of oxidation of ingested carbohydrate occur with intakes of ~1.5–1.8 g/min of multiple transportable carbohydrates

## What's New: Carbs

Confirmation of using different types of carbs

- Consumption of a CHO beverage containing glucose and fructose results in improved 100-km cycling performance compared with an isocaloric glucose-only beverage.
- Different transporters (which is a limiting factor in uptake)
- Triplett D et al An isocaloric glucose-fructose beverage's effect on simulated 100-km cycling performance compared with a glucose-only beverage Int J Sport Nutr Exerc Metab. 2010 Apr;20(2):122-31

## Science Lesson 2

- Specificity in Research
  - What is being measured
  - What changed
  - What didn't change
  - How relevant are the measures to changes in performance?

## Extrapolation

- Carbohydrate feedings before, during, or in combination improve cycling endurance performance. Journal of Applied Physiology. 71(3):1082-8, 1991.

### TIME TO EXHAUSTION (70% VO<sub>2</sub> Max)

- No carbohydrate (PP), 201 mins
- Pre-exercise carbohydrate feeding (CP) +18%
- Carbohydrate feedings during exercise (PC) +32%
- Combination of carbohydrate feedings before and during exercise (CC) +44%

## What's New: Carbs

- Manipulating macronutrient intake to change fuel utilisation – fat.
- Modifying Carbohydrate intake to change metabolic adaptations to training
- VERY confusing depending on measures;
  - enzyme levels/activity
  - fuel utilisation
  - training response
- Stay Tuned!
- Cox GR et al Daily training with high carbohydrate availability increases exogenous carbohydrate oxidation during endurance cycling. J Appl Physiol. 2010 Jul;109(1):126-34
- Stannard SR et al Adaptations to skeletal muscle with endurance exercise training in the acutely fed versus overnight-fasted state. J Sci Med Sport. 2010 Jul;13(4):465-9

## What We Knew: Protein

- Protein is good
- Too much doesn't damage healthy kidneys
- Upper limit 1.5 to 2.0 g/kg/d
- Timing more important than quantity
  - Synthesis increase up to 48 hours post RT (some evidence lower requirements in long term trained)

## What's New: Protein

- More research suggesting a 'minimum' amount of protein per meal to be anti-catabolic
  - at least 10-15 g protein per meal
  - 20 g post workout
  - Or 6-8g essential aminos

## What's New: CHO + Protein

- Is the difference in carb + protein studies due to protein or extra calories (usually matched for CHO)
- Chocolate milk provided similar muscle recovery responses to an isocaloric CHO beverage
- Muscle soreness and Mb were not significantly different between treatments
- What changed
  - Milk had lower CK (crude measure of muscle damage), questionable significance
- What didn't change
  - Myoglobin (Mb), muscle soreness, various fatigue ratings
  - isometric quadriceps force, T-test and vertical jump
- Gilson et al., Effects of chocolate milk consumption on markers of muscle recovery following soccer training: a randomized crossover study Journal of the International Society of Sports Nutrition 2010, 7:19



## What's New: CHO + Protein

### Meta-Analysis

- CHO + Protein > Carbs when matched for carb quantity
- CHO + Protein = Carbs when matched for calories
- Thus, the ergogenic effect of protein seen in isocarbohydrate studies may be because of a generic effect of adding calories (fuel) as opposed to a unique benefit of protein. Further research is warranted before a clear conclusion can be drawn.
- Stearns RL et al Effects of ingesting protein in combination with carbohydrate during exercise on endurance performance: a systematic review with meta-analysis. J Strength Cond Res. 2010 Aug;24(8):2192-202

## What's New: CHO + Protein

- What are you measuring?
- CHO ingestion has been well established as the most important determinant of muscle glycogen synthesis.
- Also taking protein and/ or amino acids does not seem to further increase muscle glycogen synthesis rates when CHO intake exceeds 1.2 g/kg/hr.
- If not practical, small amount of protein (0.2-0.4 g/kg/hr) with less CHO (0.8 g/kg/hr)
- Protein and/or amino acid administration is warranted to;
  - stimulate muscle protein synthesis
  - inhibit protein breakdown
  - allow net muscle protein accretion.
- Beelen M et al Nutritional strategies to promote postexercise recovery. Int J Sport Nutr Exerc Metab. 2010 Dec;20(6):515-32.

## What We Knew: Hydration

- Physical and mental performance decreased at 2% dehydration
- Heat illness at 4%
- Can't replace water at rate it is lost.

## What's New: Hydration

- Beverage Temperature
- Beijing 2008
- Slurpees in certain events
- Cold fluid may attenuate T(c) rise and improve exercise performance in the heat (findings mixed.)
- Research using well-trained athletes and fluid-ingestion protocols replicating competition scenarios is required.
- Burdon CA et al Influence of beverage temperature on exercise performance in the heat: a systematic review. *Int J Sport Nutr Exerc Metab.* 2010 Apr;20(2):166-74.



## What We Knew: Creatine

- Creatine monohydrate is the most effective ergogenic nutritional supplement currently available to athletes in terms of increasing high-intensity exercise capacity and lean body mass during training.
- Most common dosages:
- 5-7 day loading + 3-5 x 5g per day then 3-5g maintenance
  - 3-5g per day
  - 0.3g/kg loading + 0.03g/kg maintenance
  - Some authors recommend cycling usage
  - Caffeine negates effect???
  - Pre/Post Workout?

Buford TW, et al : International Society of Sports Nutrition position stand: creatine supplementation and exercise. *J Int Soc Sports Nutr* 2007, 4:6.  
<http://jissn.com/content/pdf/1550-2783-4-6.pdf>

## What We Knew: Creatine

- The only clinically significant side effect occasionally reported from creatine monohydrate supplementation has been the potential for weight gain
- enhances both gene expression and satellite cell activation involved in hypertrophic response - i.e. weight gain is not just water!
- Numerous forms and delivery systems for creatine (due to demand or marketing?)
- None shown to be conclusively superior or able to elevate muscle creatine levels above the observed 160mmol/kg BW ceiling.

## What's New: Creatine

- creatine supplementation may
  - increase resting muscle total creatine,
  - muscle creatine phosphate
  - plasma volume
  - may lead to a reduction in oxygen consumption during submaximal exercise
  - creatine supplementation does not improve sprint performance at the end of endurance cycling
- Hickner *et al.*, Effect of 28 days of creatine ingestion on muscle metabolism and performance of a simulated cycling road race *Journal of the International Society of Sports Nutrition* 2010, 7:26

## What's New: Creatine

- Muscle disorders (i.e., Duchenne and inflammatory myopathies)
- Central nervous diseases (i.e., Parkinson's, Huntington's, and Alzheimer's)
- Bone and metabolic disturbances (i.e., osteoporosis and type II diabetes)
- Kley RA et al Creatine for treating muscle disorders. *Cochrane Database Syst Rev.* 2011 Feb 16;2:CD004760.
- Gualano B, Artioli GG, Poortmans JR, et al. Exploring the therapeutic role of creatine supplementation. *Amino Acids* 2010;38:31-44.

## What's New: Creatine

- Creatine supplementation combined with an exercise program improves glycemic control in type 2 diabetic patients.
- The underlying mechanism seems to be related to an increase in GLUT-4 recruitment to the sarcolemma.
- Creatine supplementation does not impair kidney function in type 2 diabetic patients:
- Gualano B et al Creatine in Type 2 Diabetes: A Randomized, Double-Blind, Placebo- Controlled Trial *Med Sci Sports Exerc.* 2010 Sep 24.
- Gualano B et al Creatine supplementation does not impair kidney function in type 2 diabetic patients: a randomized, double-blind, placebo-controlled, clinical trial. *Eur J Appl Physiol.* 2010 Oct 26

## HMB — beta-hydroxy-beta-methylbutyrate

- Metabolised in skeletal muscle tissue and the liver.
- Both leucine and KIC touted anti-catabolic, enhance recovery and/or increase protein synthesis.

Raw Meat (2.3kg)  
↓  
Leucine (60g)  
↓  
KIC (30g)  
↓  
HMB (3g)



## What We Know: HMB

- Inhibit protein degradation
- 1.5 to 3 g/d of calcium HMB
- Increase muscle mass and strength particularly among untrained subjects initiating training and the elderly.
- Seems to be ineffective for trained!

## What's New: HMB

- 14 days of 3 g/day HMB and 0.3 g/day KIC
- Used untrained men and an unaccustomed exercise
- Measures
  - Delayed-onset muscle soreness
  - CK activity
  - isometric and concentric torque
  - HMB + KIC had no significant effect on any of the indices of muscle damage.
  - Was a trend in torque??!!
- Nunan D et al Exercise-induced muscle damage is not attenuated by beta-hydroxy-beta- methylbutyrate and alpha-ketoisocaproic acid supplementation. J Strength Cond Res. 2010 Feb;24(2):531-7.

## What We Knew: Glucosamine

- Strong theoretical basis
- Lots of good animal studies
- Mixed human results re
  - Decreasing inflammation/pain
  - Stopping cartilage degeneration
  - Regenerating cartilage

## Science Lesson

- The Placebo Effect
  - The mind is extremely powerful, but easily fooled (think magic and optical illusions)
  - Science tries to eliminate the 'human factor'.
  - Different colour pills
  - Injections vs pills
  - Sham surgery

## What We Knew: Glucosamine

- Glucosamine/Chondroitin Arthritis Intervention Trial (GAIT) 2006
  - 1583 patients into five groups
  - 60.1 % of people on placebo had 20% or greater improvement in knee pain after 24 weeks
  - Only drug (celecoxib) was sig different.
  - Cherry pick most severe pain group, also different.

## What We Knew: Glucosamine

- Glucosamine Sulfate vs Glucosamine HCL?
- Was funding an issue?
- 2008 study on hip arthritis was first major nail in coffin! 2 year study
- Glucosamine sulfate was no better than placebo in reducing symptoms and progression of hip osteoarthritis.
- More study required ??

• Rozendaal RM et al Effect of glucosamine sulfate on hip osteoarthritis: a randomized trial. *Ann Intern Med.* 2008 Feb 19;148(4):268-77.

## What's New: Glucosamine

- Follow Up to GAIT
  - 662 patients for 2 years!
  - no treatment achieved a clinically important difference in pain or function as compared with placebo
- 6 month Lower Back Pain Study
  - Among patients with chronic LBP and degenerative lumbar OA, 6-month treatment with oral glucosamine compared with placebo did not result in reduced pain-related disability after the 6-month intervention and after 1-year follow-up
- Sawitzke AD et al Clinical efficacy and safety of glucosamine, chondroitin sulphate, their combination, celecoxib or placebo taken to treat osteoarthritis of the knee: 2-year results from GAIT. *Ann Rheum Dis.* 2010 Aug;69(8):1459-64
- Wilkens P Effect of glucosamine on pain-related disability in patients with chronic low back pain and degenerative lumbar osteoarthritis: a randomized controlled trial. *JAMA.* 2010 Jul 7;304(1):45-52.

## What's New: Glucosamine

- Large Meta-analysis
- Glucosamine, chondroitin, and their combination do not reduce joint pain vs placebo
- Glucosamine, chondroitin, and their combination do not impact on narrowing of joint space vs placebo
- Wandel S et al Effects of glucosamine, chondroitin, or placebo in patients with osteoarthritis of hip or knee: network meta-analysis. *BMJ.* 2010 Sep 16;341:c4675. doi: 10.1136/bmj.c4675.

## What We Knew: Sodium Bicarb

- Used to buffer lactic acid and decrease fatigue, best for sports 1-7 minutes or repeated high-intensity bursts.
- Side effects can be nausea, vomiting, cramping
- 0.3g/kg bodyweight with plenty of water
- Still must 'pace-self' otherwise benefit lost

## What's New: Acid Buffers

- More punches landed successfully in four 3 min rounds with 1 min rest using 0.3 g/kg Sodium Bicarb
- Three x 30-s maximal efforts with a three min recovery between each effort – higher speeds and longer distance.
- 8 x 25-m freestyle maximal effort sprints each separated by 5 seconds - 2% decrease in total swim time
- Siegler JC, Hirscher K. Sodium bicarbonate ingestion and boxing performance. *J Strength Cond Res* 2010 Jan;24(1):103-8.
- Siegler JC et al Metabolic alkalosis, recovery and sprint performance *Int J Sports Med.* 2010 Nov;31(11):797-802.
- Siegler JC, Gleadall-Siddall DO. Sodium bicarbonate ingestion and repeated swim sprint performance. *J Strength Cond Res.* 2010 Nov;24(11):3105-11.

## What's New: Acid Buffers

- Rugby - 25-min warm-up followed by 9 min of high-intensity rugby-specific training followed by a rugby-specific repeated-sprint test
- Did not significantly improve exercise performance despite positively altering blood measures.
- More and worse GI symptoms may negatively affect physical performance
- Cameron SL et al Increased blood pH but not performance with sodium bicarbonate supplementation in elite rugby union players *Int J Sport Nutr Exerc Metab.* 2010 Aug;20(4):307-21.

## What We Knew: $\beta$ -Alanine

- Histidine +  $\beta$ -alanine = Carnosine
- Found in meat- highest in chicken and turkey
- Levels are higher in sprinters, bodybuilders and high intensity intermittent exercise team sport athletes (higher in Type II fibres!)
- 2.4-6.4 g / day of for 28 days has been shown to increase carnosine levels by 37-80%
- Side effects - paraesthesia (pins and needles) – harder to do blinded placebo tests with
- Solution divided doses or time-released capsules.

## What We Knew: $\beta$ -Alanine

### Suggested roles of carnosine

- include acting as an intramuscular antioxidant
- regulation of calcium sensitivity and excitation-contraction coupling
- protection against glycation by acting as a sacrificial peptide
- prevention of protein-protein cross links by reacting with protein-carbonyl groups
- Intramuscular buffer against pH decline during exercise.

## What We Knew: $\beta$ -Alanine

- Increase work capacity, decreases rate of fatigue
- decreases rate of fatigue and decrease time to fatigue
- Total work done, time to exhaustion, physical working capacity at fatigue threshold, power output at lactate threshold, attenuated fatigue during repeated bouts of resistance training
- and final 30 second sprint performance during a 2 hour time trial
- increase the number of repetitions one can do
- increased lean body mass
- increase knee extension torque
- Majority have, but not all studies have shown benefit

## What's New: $\beta$ -Alanine

- $\beta$ -Alanine supplementation for 28 days enhanced sub-maximal endurance performance by delaying OBLA.
- However,  $\beta$ -Alanine supplemented individuals had a reduced aerobic capacity as evidenced by the decrease in  $VO_{2max}$  values post supplementation.
- 28 days of  $\beta$ A supplementation may enhance submaximal endurance performance as measured by OBLA.
- Jordan et al., Effect of beta-alanine supplementation on the onset of blood lactate accumulation (OBLA) during treadmill running: Pre/post 2 treatment experimental design *Journal of the International Society of Sports Nutrition* 2010, 7:20

## What's New: $\beta$ -Alanine

- Cyclists used 4.8 g/day for 4 weeks
- Exercise-induced acidosis was significantly reduced (without affecting blood lactate and bicarbonate concentrations)
- Second study done on women WITH EXERCISE
  - No additional benefit of  $\beta$ -Alanine
  - High Intensity Interval Training may increase Carnosine
- Baguet A et al Beta-alanine supplementation reduces acidosis but not oxygen uptake response during high-intensity cycling exercise. *Eur J Appl Physiol.* 2010 Feb;108(3):495-503.
- Walter AA et al Six weeks of high-intensity interval training with and without beta- alanine supplementation for improving cardiovascular fitness in women. *J Strength Cond Res.* 2010 May;24(5):1199-207

## What's New: $\beta$ -Alanine

### Literature Reviews

- Sale C et al Effect of beta-alanine supplementation on muscle carnosine concentrations and exercise performance. *Amino Acids.* 2010 Jul;39(2):321-33.
- Artioli GG et al Role of beta-alanine supplementation on muscle carnosine and exercise performance. *Med Sci Sports Exerc.* 2010 Jun;42(6):1162-73.
- Derave W et al Muscle carnosine metabolism and beta-alanine supplementation in relation to exercise and training. *Sports Med.* 2010 Mar 1;40(3):247-63

## You Can't Do Everything (WELL)

- Too many components may detract from overall goal!
- Some supplements contain many ingredients
- Does each key ingredient appear in appropriate doses?
- Some products contain patented 'blends' – quantities unknown!

## What We Knew: NO Stimulators

### Nitric Oxide

- can dilate arteries to increase blood flow
- help maintain endothelial elasticity
- prevent platelets from adhering to artery walls
- mediate erections through smooth muscle relaxation
- ? increase capacity for exercise ?

### NO can play an integral part in

- the immune system
- assist in memory function
- sleep regulation

## What We Knew: NO Stimulators

- Like Glutamine many benefits extrapolated from clinical populations
- Generally no increases in performance
- LOTS of anecdotal evidence
- Why L-arginine? Based on research using 20-30g intravenous L-arginine, 3-5 grams orally.
- Nitric oxide synthase enzymes appear most important / limiting factor!

## What's New: NO Stimulators

- Glycine Propionyl-L-Carnitine (GlycoCarn®) and three different pre-workout nutritional supplements on;
  - measures of skeletal muscle oxygen saturation (StO2)
  - blood nitrate/nitrite (NOx)
  - lactate (HLA)
  - malondialdehyde (MDA) (lipid specific oxidative stress)
  - exercise performance
    - Bench press power (throws) - three throws using 30% of 1RM.
    - Workload 10 maximal sets - Hammer Strength™ supine bench press @ 50% of 1RM.
    - Perceived muscle "pump" in the upper body using a visual analog scale (0-10 scale)
    - Chest circumference

Bloomer et al., Comparison of pre-workout nitric oxide stimulating dietary supplements on skeletal muscle oxygen saturation, blood nitrate/nitrite, lipid peroxidation, and upper body exercise performance in resistance trained men Journal of the International Society of Sports Nutrition 2010, 7:16

## What's New: NO Stimulators

### Supplement 1

- Glucose Polymer Blend, Creatine Monohydrate, NO2 Complex [L-Arginine, L-Arginine Alpha-Ketoglutarate
- (A-AKG), L-Arginine Ketoisocaproate (A-KIC)], Guanipiro™ (Guanidino Propionic Acid), Salicylic Acid 15%, Panax Ginseng Extract
- L-Tyrosine, Methylxanthines (Caffeine), NAC (N-Acetyl-Cysteine), N-Acetyl-Tyrosine, Glucuronolactone,
- Rhodiola Rosea Root Extract (Standardized To 5% Total Rosavins), Ginko Biloba Extract
- Taurine, L-Leucine, L-Glutamine, L-Valine, L-Isoleucine, L-Citrulline AKG, Turkesterone (11,20)
- Dihydroxyecdysone From Ajuga Turkestanica Extract), Choline Bitartrate
- Indole-3-Carbinol, 4-Hydroxyisoleucine (From Fenugreek Seed Extract), Cinnamon Bark Extract, Bacopa Monniera
- Potassium Glycerophosphate, Magnesium Glycerophosphate, Alpha Lipoic Acid, Bioperine™

## What's New: NO Stimulators

### Gaspari Nutrition Superpump

- Glucose Polymer Blend, Creatine Monohydrate, NO2 Complex [L-Arginine, L-Arginine Alpha-Ketoglutarate
- (A-AKG), L-Arginine Ketoisocaproate (A-KIC)], Guanipiro™ (Guanidino Propionic Acid), Salicylic Acid 15%, Panax Ginseng Extract
- L-Tyrosine, Methylxanthines (Caffeine), NAC (N-Acetyl-Cysteine), N-Acetyl-Tyrosine, Glucuronolactone,
- Rhodiola Rosea Root Extract (Standardized To 5% Total Rosavins), Ginko Biloba Extract
- Taurine, L-Leucine, L-Glutamine, L-Valine, L-Isoleucine, L-Citrulline AKG, Turkesterone (11,20)
- Dihydroxyecdysone From Ajuga Turkestanica Extract), Choline Bitartrate
- Indole-3-Carbinol, 4-Hydroxyisoleucine (From Fenugreek Seed Extract), Cinnamon Bark Extract, Bacopa Monniera
- Potassium Glycerophosphate, Magnesium Glycerophosphate, Alpha Lipoic Acid, Bioperine™

## What's New: NO Stimulators

### Supplement 2

- L-Arginine AKG, L-Citrulline Malate, RC-NOS™ (Rutacarpine 95%), L-Citrulline AKG, L-Histidine AKG, NAD
- (Nicotinamide Adenine Dinucleotide), Gynostemma Pentaphyllum (Leaves & Stem) (Gyenosides 95%)
- Modified Glucose Polymers (Maltodextrin), Di-Creatine Malate, Trimethylglycine, Creatine Ethyl Ester -Beta-
- Alanine Dual Action Composite (CarnoSyn®), Sodium Bicarbonate, Sodium Creatine Phosphate Matrix, Creatinol
- O-Phosphate-Malic Acid Interfusion, Glycocyamine, Guanidino Propionic Acid, Cinnulin PF® (Aqueous Cinnamon)
- Extract (Bark), Ketoisocaproate Potassium, Creatine ABB (Creatine Alpha-Amino-N-Butyrate)
- L-Tyrosine, Taurine, Glucuronolactone, Methylxanthine (Caffeine), L-Tyrosine AKG, MCT's (Medium Chain)
- Triglycerides[Coconut], Common Periwinkle Vinpocetine 99%, Vincamine 99%, Vinburnine 99% (Whole Plant)
- Di-Calcium Phosphate, Di-Potassium Phosphate, Di-Sodium Phosphate
- Potassium Glycerophosphate, Magnesium Glycerophosphate, Glycerol Stearate

## What's New: NO Stimulators

### BSN N.O. Xplode

- L-Arginine AKG, L-Citrulline Malate, RC-NOS™ (Rutacarpine 95%), L-Citrulline AKG, L-Histidine AKG, NAD
- (Nicotinamide Adenine Dinucleotide), Gynostemma Pentaphyllum (Leaves & Stem) (Gyenosides 95%)
- Modified Glucose Polymers (Maltodextrin), Di-Creatine Malate, Trimethylglycine, Creatine Ethyl Ester -Beta-
- Alanine Dual Action Composite (CarnoSyn®), Sodium Bicarbonate, Sodium Creatine Phosphate Matrix, Creatinol
- O-Phosphate-Malic Acid Interfusion, Glycocyamine, Guanidino Propionic Acid, Cinnulin PF® (Aqueous Cinnamon)
- Extract (Bark), Ketoisocaproate Potassium, Creatine ABB (Creatine Alpha-Amino-N-Butyrate)
- L-Tyrosine, Taurine, Glucuronolactone, Methylxanthine (Caffeine), L-Tyrosine AKG, MCT's (Medium Chain)
- Triglycerides[Coconut], Common Periwinkle Vinpocetine 99%, Vincamine 99%, Vinburnine 99% (Whole Plant)
- Di-Calcium Phosphate, Di-Potassium Phosphate, Di-Sodium Phosphate
- Potassium Glycerophosphate, Magnesium Glycerophosphate, Glycerol Stearate

## What's New: NO Stimulators

### Supplement 3

- D-Glucose Monosaccharide, L-Arginine, Taurine, L-Aspartic Acid, Disodium Phosphate, Dipotassium Phosphate, Dicalcium Phosphate, Xanthinol Nicotinate, L-Arginine Ketoisocaproic Acid, L-Arginine Ethyl Ester HCL, L-Norvaline, L-Norvaline Ethyl Ester HCL, Citrulline Malate, L-Citrulline Ethyl Ester, L-Histidine Alpha-Ketoglutarate, Gynostemma Pentaphyllum Extract (Root) (Standardized To 95% Gyenosides), Acetyl-L-Carnitine
- L-Arginine Dihydrochloride, Artichoke Extract (As Cynara Scolymus L)(Root) Standardized To 5% Chlorogenic Acid, Crataegus Pinnatifida Bunge Extract (Fruit)
- Maltodextrin, Creatine Monohydrate, Creatine Anhydrous, Creatine Malate, Creatine Taurinate, Creatine HCA, Creatine L-Pyroglytamate, Taurine Ethyl Ester HCL, Taurine Alpha-Ketoglutarate, 18 Beta Glycyrrhetic Acid
- Coniolum Versicolor Powder (Plant) Glycine, L-Leucine, L-Isolucine, L-Valine, Beta Alanine, Beta Alanine Ethyl Ester HCL, L-Leucine Methyl Ester HCL, L-Leucine Alpha-Ketoglutarate, L-Leucine Isovaleric Acid, L-Isoleucine Ethyl Ester HCL, L-Isoleucine Methyl Ester HCL, L-Valine Ethyl Ester HCL, L-Valine Alpha-Ketoglutarate, Alpha Amino N-Butyrate Caffeine Anhydrous (Standardized For 117 Mg Caffeine), Yerba Mate Powder (As Ilex Paraguariensis)(Leaf), N-Acetyl-L-Carnitine HCL, Yohimbine HCL (Pausinystalia Yohimbe)(Bark), Evodia Rutaecarpa Extract (As Tetradium Rutecarpum)(Fruit) (Standardized For 10% Evodiamine), Black Tea Extract (As Camellia Sinensis)(Leaf) (Standardized For 70% Polyphenols, 50% Catechins, 25% EGCG), Theobroma Cacao Extract (Seed) (Standardized For 6% Theobromine), White Tea Extract (As Camellia Sinensis)(Leaf) (Standardized For 50% Polyphenols, 35% Catechins, 15% EGCG), White Willow Extract (As Salix Alba)(Bark) (Standardized For 25% Salicin) N-Acetyl-L-Tyrosine, L-Tyrosine, Sulbutiamine, Vinpocetine, Alpha Glycerophosphocholine, Cis-9, 10-Octadecenoamide, Huperzine-A (As Huperzia Serrata) Quercetin Dihydrate, Dihydroxy-Diosgenin (25R-5 Alpha-Spirostan-2-Alpha, 3-Beta), N-Acetyl-L-Cysteine, N-Acetyl-5-Methoxytryptamine

## What's New: NO Stimulators

### MuscleTech naNO Vapor

- D-Glucose Monosaccharide, L-Arginine, Taurine, L-Aspartic Acid, Disodium Phosphate, Dipotassium Phosphate, Dicalcium Phosphate, Xanthinol Nicotinate, L-Arginine Ketoisocaproic Acid, L-Arginine Ethyl Ester HCL, L-Norvaline, L-Norvaline Ethyl Ester HCL, Citrulline Malate, L-Citrulline Ethyl Ester, L-Histidine Alpha-Ketoglutarate, Gynostemma Pentaphyllum Extract (Root) (Standardized To 95% Gyenosides), Acetyl-L-Carnitine
- L-Arginine Dihydrochloride, Artichoke Extract (As Cynara Scolymus L)(Root) Standardized To 5% Chlorogenic Acid, Crataegus Pinnatifida Bunge Extract (Fruit)
- Maltodextrin, Creatine Monohydrate, Creatine Anhydrous, Creatine Malate, Creatine Taurinate, Creatine HCA, Creatine L-Pyroglytamate, Taurine Ethyl Ester HCL, Taurine Alpha-Ketoglutarate, 18 Beta Glycyrrhetic Acid
- Coniolum Versicolor Powder (Plant) Glycine, L-Leucine, L-Isolucine, L-Valine, Beta Alanine, Beta Alanine Ethyl Ester HCL, L-Leucine Methyl Ester HCL, L-Leucine Alpha-Ketoglutarate, L-Leucine Isovaleric Acid, L-Isoleucine Ethyl Ester HCL, L-Isoleucine Methyl Ester HCL, L-Valine Ethyl Ester HCL, L-Valine Alpha-Ketoglutarate, Alpha Amino N-Butyrate Caffeine Anhydrous (Standardized For 117 Mg Caffeine), Yerba Mate Powder (As Ilex Paraguariensis)(Leaf), N-Acetyl-L-Carnitine HCL, Yohimbine HCL (Pausinystalia Yohimbe)(Bark), Evodia Rutaecarpa Extract (As Tetradium Rutecarpum)(Fruit) (Standardized For 10% Evodiamine), Black Tea Extract (As Camellia Sinensis)(Leaf) (Standardized For 70% Polyphenols, 50% Catechins, 25% EGCG), Theobroma Cacao Extract (Seed) (Standardized For 6% Theobromine), White Tea Extract (As Camellia Sinensis)(Leaf) (Standardized For 50% Polyphenols, 35% Catechins, 15% EGCG), White Willow Extract (As Salix Alba)(Bark) (Standardized For 25% Salicin) N-Acetyl-L-Tyrosine, L-Tyrosine, Sulbutiamine, Vinpocetine, Alpha Glycerophosphocholine, Cis-9, 10-Octadecenoamide, Huperzine-A (As Huperzia Serrata) Quercetin Dihydrate, Dihydroxy-Diosgenin (25R-5 Alpha-Spirostan-2-Alpha, 3-Beta), N-Acetyl-L-Cysteine, N-Acetyl-5-Methoxytryptamine

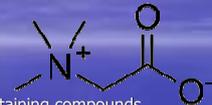
## What's New: NO Stimulators

- What Changed
  - GlycoCam® in terms of higher StO2 at the start of exercise.
  - GlycoCam® resulted in a 13.7% decrease in MDA (potentially greater endurance)
- What didn't changed
  - Bench press power (throws) - three throws using 30% of 1RM.
  - Workload 10 maximal sets - Hammer Strength™ supine bench press @ 50% of 1RM.
  - Perceived muscle "pump" in the upper body using a visual analog scale (0-10 scale)
  - Chest circumference
- i.e PERFORMANCE DIDN'T CHANGE

## What's We Knew: NO Stimulators

### Betaine

- trimethyl derivative of glycine
- Daily intake 1-2.5 g/day.
- Synthesised via oxidation of choline-containing compounds
- Increases muscle creatine (in chickens!)
- 1.25 g of betaine twice per day.
- One Study
  - No significant changes in repetitions for BP or Squat
  - Improvements in bench press throw, power, isometric bench press force, vertical jump power and isometric squat force
- Second Study
  - Improve muscle endurance of the squat exercise, and increase the quality of repetitions performed
  - Note no change in
    - Repetition maximum Bench press or squat at end of study
    - Bench Press Throw, Wingate Test, Vertical Jump and some mean and peak power measures



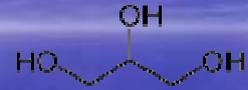
## What's New: NO Stimulators

- Three different study designs
  - Acute intake of betaine at 1.25 and 5.00 grams
  - Chronic intake of betaine at 2.5 grams per day for 14 days
  - Chronic [6 grams of betaine per day for 7 days] followed by acute intake [6 grams]
- Other mechanisms aside from increasing circulating nitric oxide are likely responsible for the reported ergogenic benefit of betaine supplementation that has been reported by others.

Bloomer et al.: Effect of betaine supplementation on plasma nitrate/nitrite in exercise-trained men. Journal of the International Society of Sports Nutrition 2011 8:5.

## What We Knew: Glycerol

- Also called glycerine
- increase fluid retention
- Cheap, variety of uses
- ? help athletes prevent dehydration
- mixed results on whether improves exercise capacity



## What's New: Glycerol

- On WADA banned list as of 2010.
- Classed as a plasma expander!
- [http://www.wada-ama.org/rtecontent/document/2010\\_Prohibited\\_List\\_FINAL\\_EN\\_Web.pdf](http://www.wada-ama.org/rtecontent/document/2010_Prohibited_List_FINAL_EN_Web.pdf)



## What We Knew: Anti-Oxidants

- Strong theory
- Lots of evidence for changes in oxidation rates, enzymes and markers
- Poor evidence for performance enhancement
- Exercise results in body making more anti-oxidants
- May have health benefits/longevity
- N-acetyl-Cystine may enhance submaximal performance in events >30 mins
- Recent suggestions/research that they may inhibit adaptation
- Oxidative stress may be the stimulus for some exercise induced changes

## What We Knew: Anti-Oxidants

- Recent suggestions/research that they may inhibit adaptation
- Oxidative stress may be the stimulus for some exercise induced changes
- Gomez-Cabrera MC, Domenech E, Romagnoli M, et al. Oral administration of vitamin C decreases muscle mitochondrial biogenesis and hampers training-induced adaptations in endurance performance. Am J Clin Nutr 2008;87:142–9.
- Ristow M, Zarse K, Oberbach A, et al. Antioxidants prevent health-promoting effects of physical exercise in humans. Proc Natl Acad Sci USA 2009;106:8665–70.
- Powers SK, Jackson MJ. Exercise-induced oxidative stress: cellular mechanisms and impact on muscle force production. Physiol Rev 2008;88:1243–76.

## What's New: Anti-Oxidants

- Vitamin E and  $\alpha$ -lipoic acid supplementation suppresses skeletal muscle mitochondrial biogenesis, regardless of training status (in rats)
  - PGC-1 $\alpha$  mRNA
  - PGC-1 $\alpha$
  - COX IV protein
  - citrate synthase enzyme
- Strobel NA Antioxidant Supplementation Reduces Skeletal Muscle Mitochondrial Biogenesis Medicine & Science in Sports & Exercise, Publish Ahead of Print 2010

## What's New: Anti-Oxidants

- Moderately trained young men –
  - Vit C (ascorbic acid, 500 mg) and vitamin E 400 IU daily
  - 12 wk of supervised, strenuous bicycle exercise training 5 days/wk
  - Measured
    - maximal oxygen consumption
    - maximal power output
    - workload at lactate threshold
    - glycogen concentration
    - citrate synthase
    - beta-hydroxyacyl-CoA dehydrogenase activity
- No differences between the two groups adaptation to training
- Yfanti C et al Antioxidant supplementation does not alter endurance training adaptation. Med Sci Sports Exerc. 2010 Jul;42(7):1388-95

## What We Knew: Caffeine

- 1.) Caffeine is effective for enhancing sport performance in trained athletes when consumed in low-to-moderate dosages (~3-6 mg/kg) and overall does not result in further enhancement in performance when consumed in higher dosages (≥ 9 mg/kg).
- 2.) Caffeine exerts a greater ergogenic effect when consumed in an anhydrous state as compared to coffee.
- 3.) It has been shown that caffeine can enhance vigilance during bouts of extended exhaustive exercise, as well as periods of sustained sleep deprivation.
- 4.) Caffeine is ergogenic for sustained maximal endurance exercise, and has been shown to be highly effective for time-trial performance.
- Goldstein et al.: International society of sports nutrition position stand: caffeine and performance. Journal of the International Society of Sports Nutrition 2010 7:5.
- <http://jissn.com/content/pdf/1550-2783-7-5.pdf>

## What We Knew: Caffeine

- 5.) Caffeine supplementation is beneficial for high-intensity exercise, including team sports such as soccer and rugby, both of which are categorized by intermittent activity within a period of prolonged duration.
- 6.) The literature is equivocal when considering the effects of caffeine supplementation on strength-power performance, and additional research in this area is warranted.
- 7.) The scientific literature does not support caffeine-induced diuresis during exercise, or any harmful change in fluid balance that would negatively affect performance.
- Elevated levels can appear in the bloodstream within 15-45 min of consumption, and peak concentrations are evident one hour post ingestion
- Goldstein et al.: International society of sports nutrition position stand: caffeine and performance. Journal of the International Society of Sports Nutrition 2010 7:5.
- <http://jissn.com/content/pdf/1550-2783-7-5.pdf>

## What's We Knew: L-Carnitine

- Main source meat 1/g per day
- Essential for Carbohydrate and Fat metabolism BUT not rate limiting step
- Studies fail to show increase in performance or affect on fuel metabolism
- Dosages studied 2-6g/day oral 65mg/kg intravenous for up to 4 months
- Muscle levels or carnitine never increased!
- Recently injection with insulin as well as oral doses 3g/day with 94g carbs has increased levels and altered fuel usage

## What We Knew: L-Carnitine

- Another study show L-Carnitine plus carbs increasing muscle carnitine levels but takes a LONG time!
- Also decreased CHO usage during low intensity exercise – 55% less muscle glycogen!
- Less anaerobic energy generation during high intensity exercise – 44% less muscle lactate and better PCr/ATP ratio.
- 11% higher work output!
- 2g L-carnitine-L-tartrate and 80g CHO twice daily for 24 weeks!
- Wall BJ et al Chronic oral ingestion of L-carnitine and carbohydrate increases muscle carnitine content and alters muscle fuel metabolism during exercise in humans J Physiol 589.4 (2011) pp 963-973 963

## What's New: Meal Frequency

### ISSN position stand: meal frequency

Research to date examining the physiological effects of meal frequency in humans is somewhat limited

1. Increasing meal frequency does not appear to favorably change body composition in sedentary populations.
2. If protein levels are adequate, increasing meal frequency during periods of hypoenergetic dieting may preserve lean body mass in athletic populations.
3. Increased meal frequency appears to have a positive effect on various blood markers of health, particularly LDL cholesterol, total cholesterol, and insulin.
4. Increased meal frequency does not appear to significantly enhance diet induced thermogenesis, total energy expenditure or resting metabolic rate.
5. Increasing meal frequency appears to help decrease hunger and improve appetite control.

La Bounty et al. Journal of the International Society of Sports Nutrition 2011, 8:4  
<http://jissn.com/content/pdf/1550-2783-8-4.pdf>