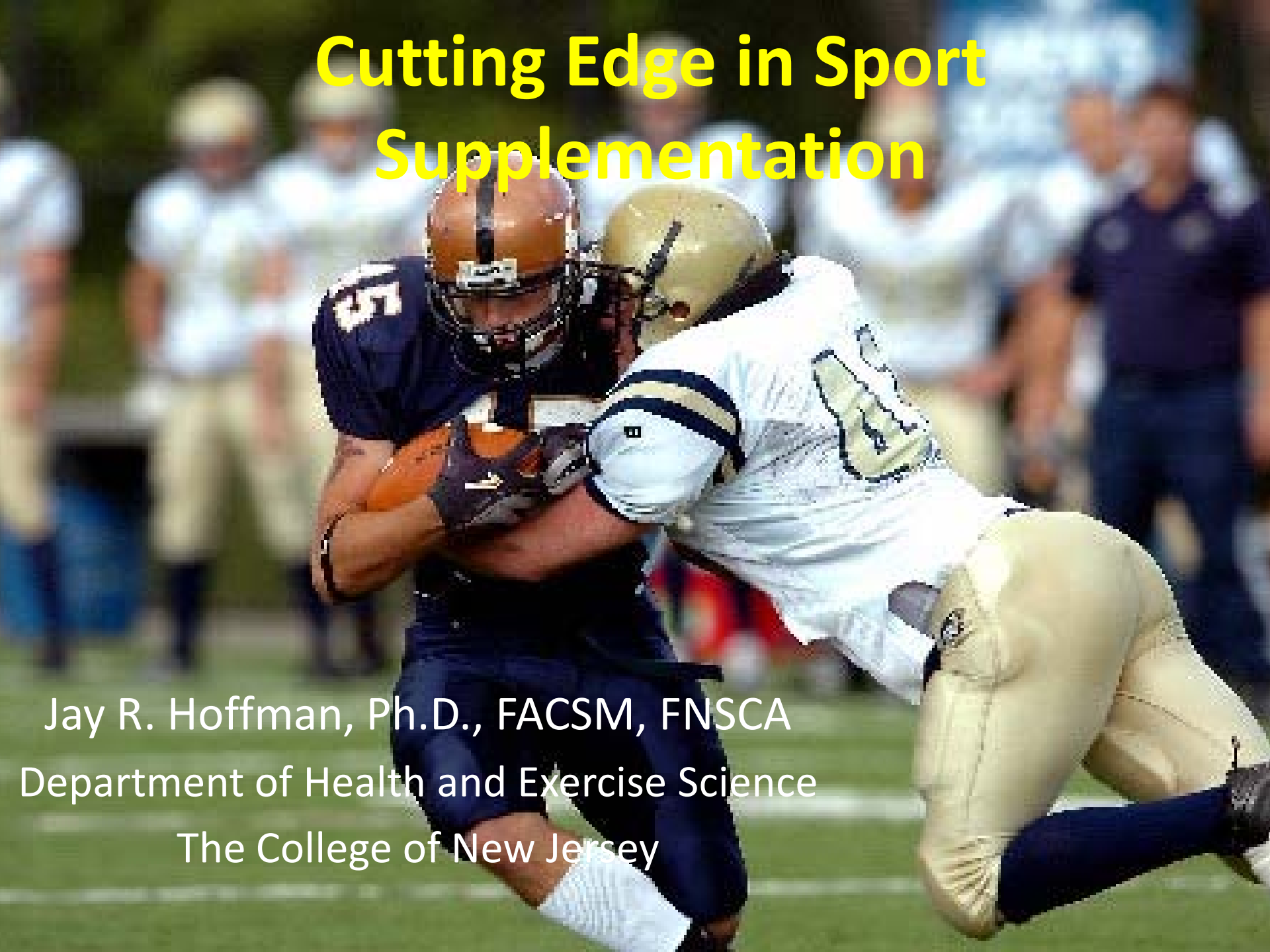
Cutting Edge in Sport Supplementation



Jay R. Hoffman, Ph.D., FACSM, FNSCA
Department of Health and Exercise Science
The College of New Jersey

Sport Supplements: Secret Stuff?

Nutritional Supplements: When to use!

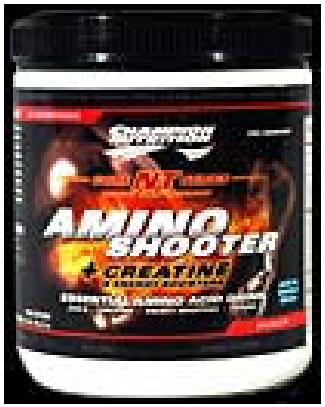
- Educating the athlete
  - Obligation to be informed
- Training program is adhering to proper training principles.
  - Overload and progression
- Sound nutrition
  - Caloric intake
  - Protein intake
- Legal and efficacious supplements

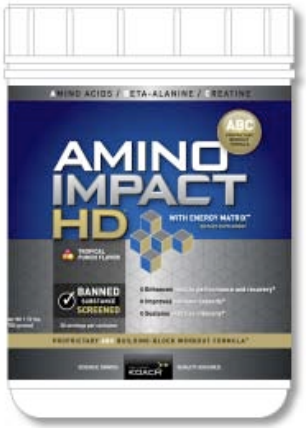
Popular Sport Supplements

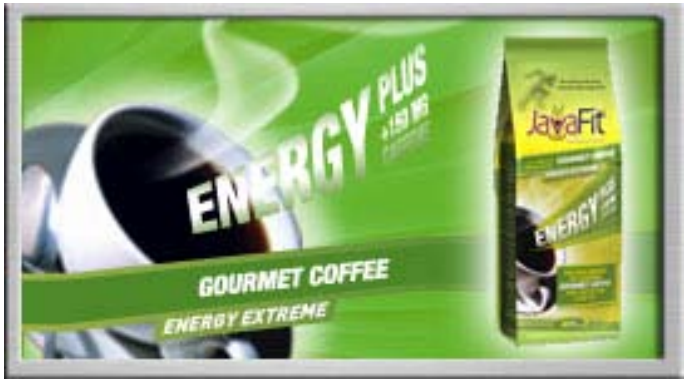
- Protein/Amino acids:
  - How much
  - Type
  - Timing
- High energy pre-workout or pre-game supplements
- Creatine
  - Dosing
  - Types
- β-alanine
- New and Interesting supplements

Discussed Yesterday

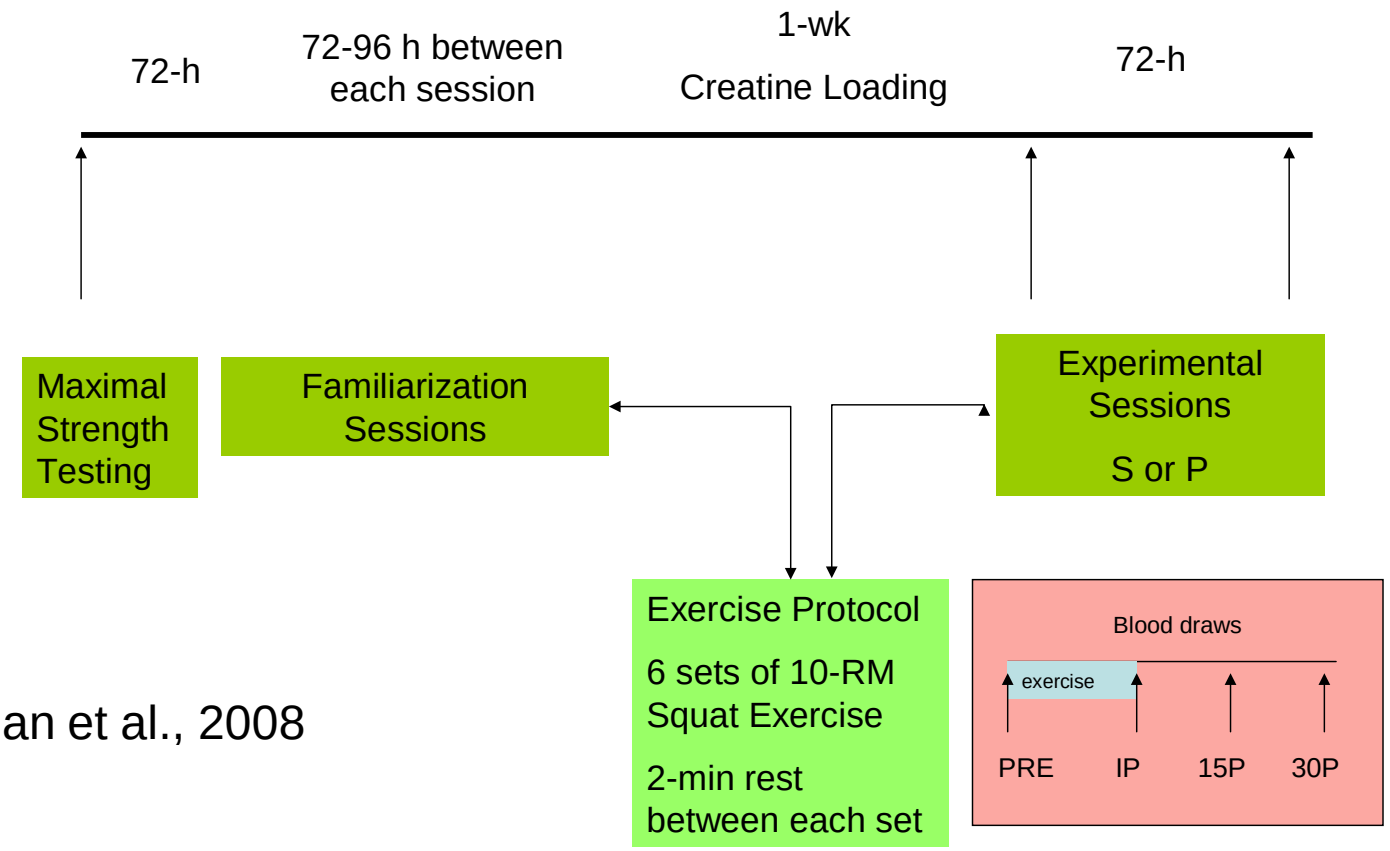
High Energy
Pre-Exercise/Game Supplements







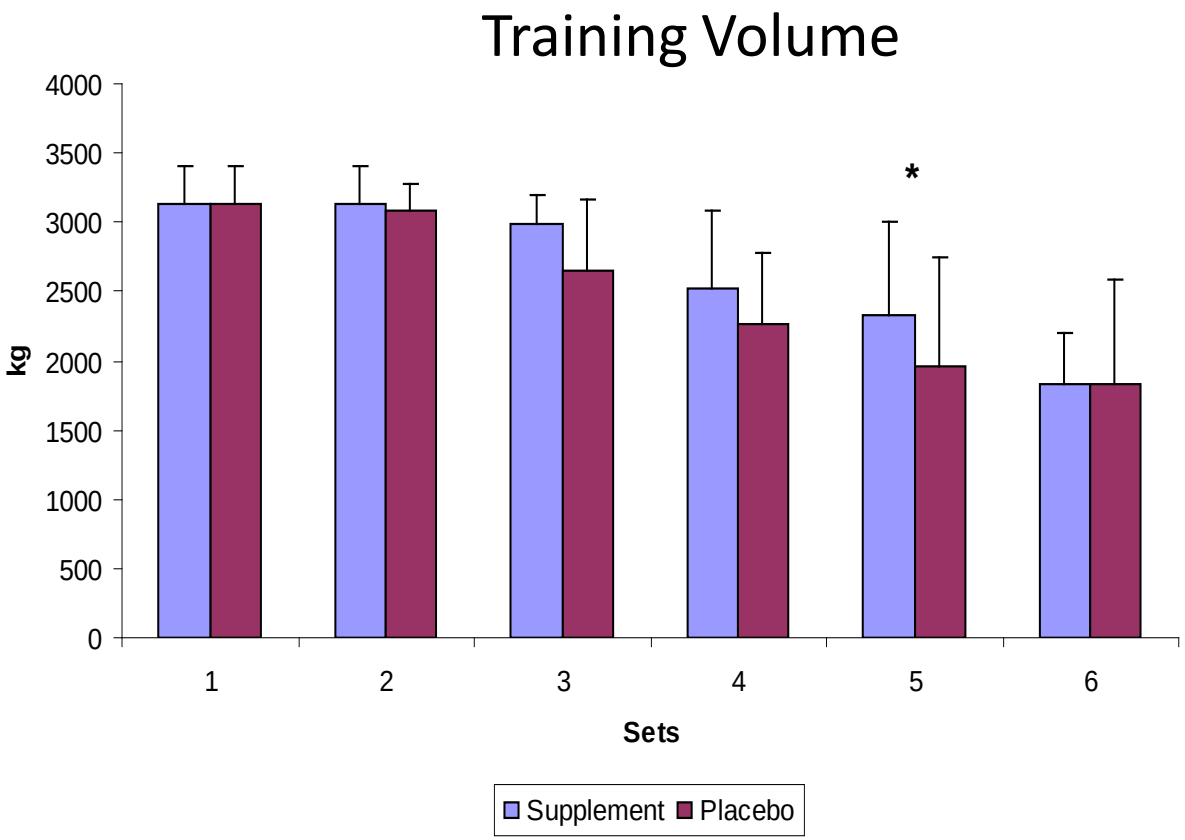
Study Design: Amino Shooter Study



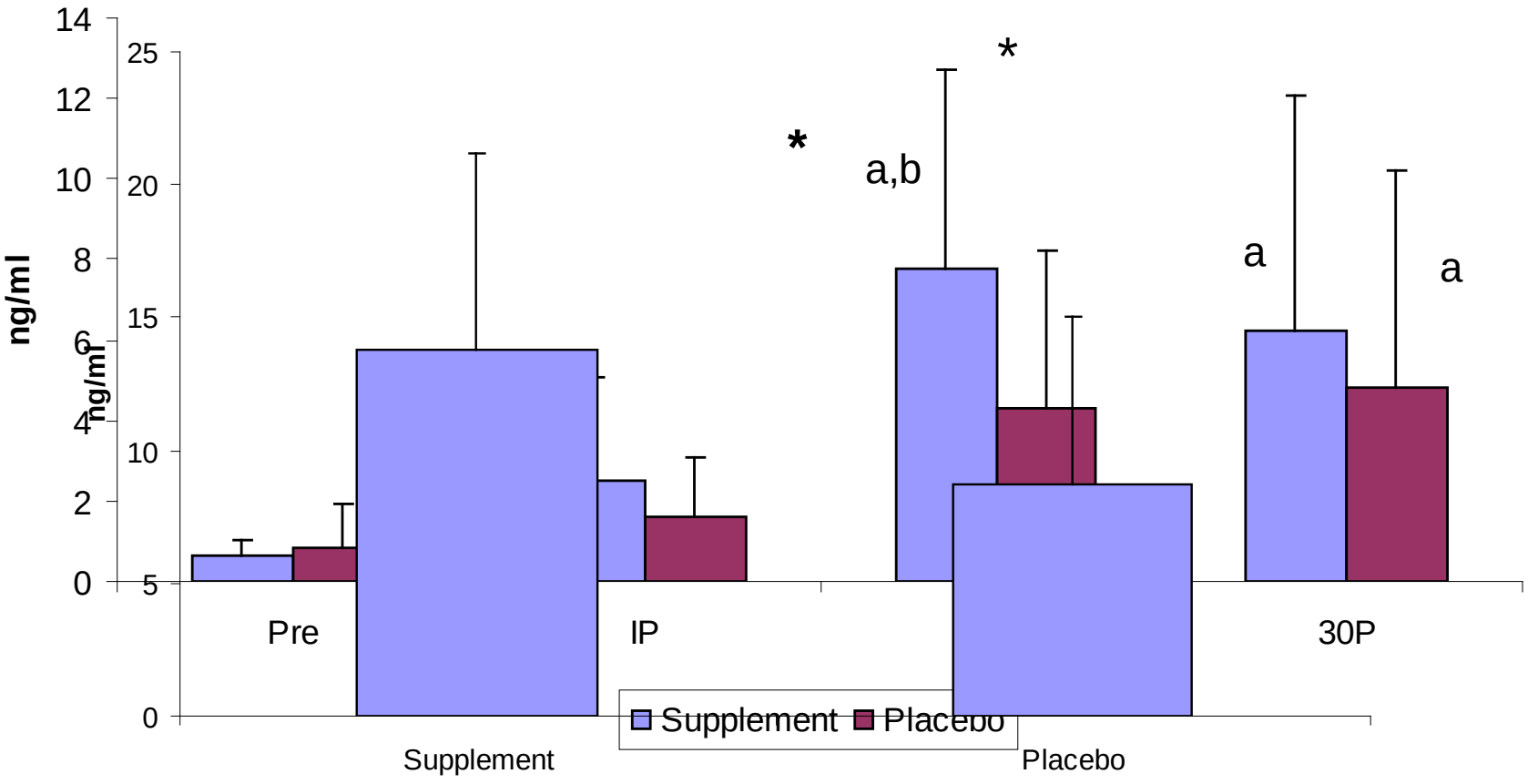
Hoffman et al., 2008

High Energy Pre-Exercise Drinks: Research

- Combination of Creatine, BCAA, caffeine, taurine and glucuronolactone

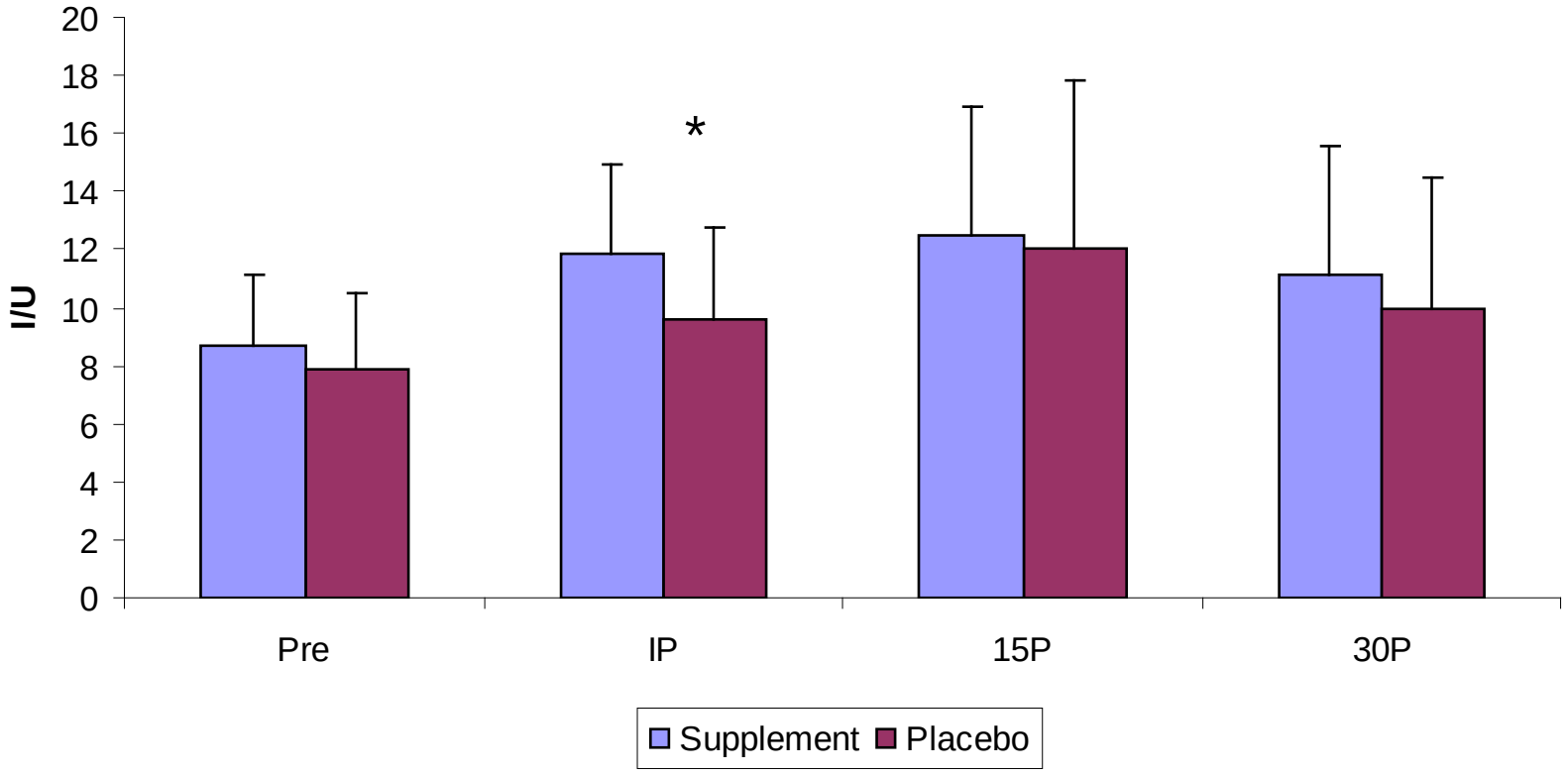


Growth Hormone



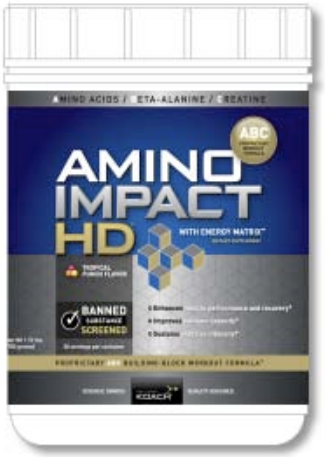
AUC

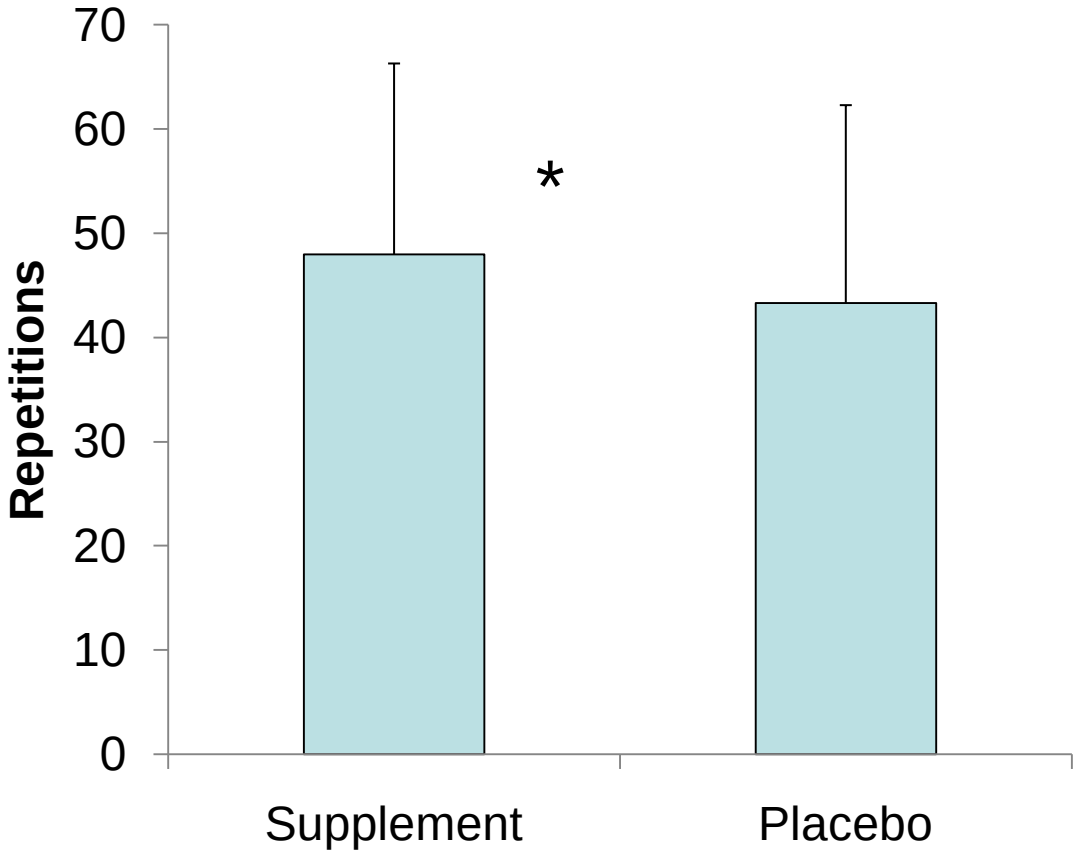
Insulin



High Energy Pre-Exercise Drinks: Research

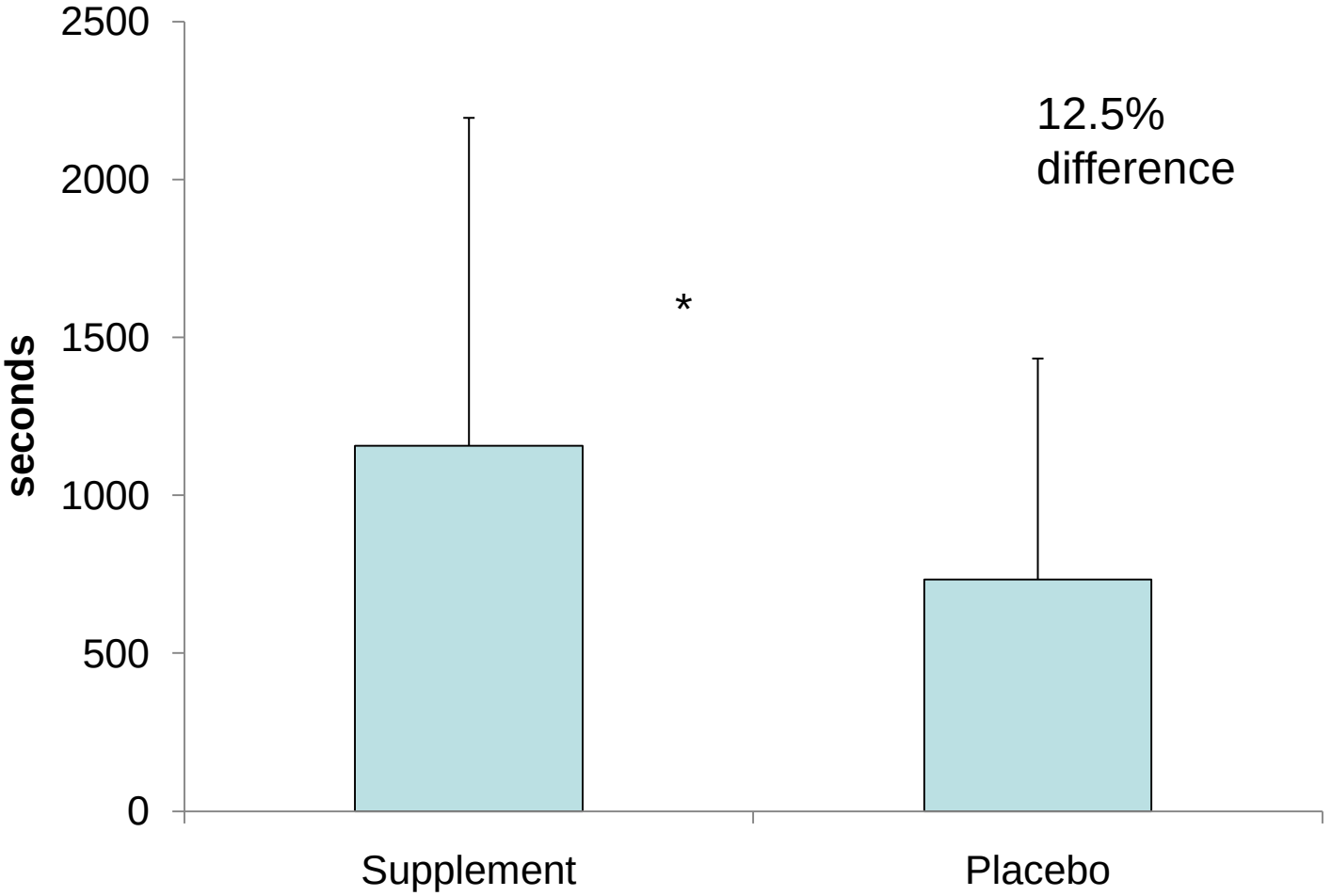
- Combination of caffeine, taurine, glucuronolactone, arginine, glutamine, creatine, β-alanine, and BCAA.





4 sets of 10 repetitions with squat, bench press and incline bench press exercises @80% with 2 min rest

Time to Exhaustion (70% VO_2max on a treadmill)



Walsh et al., 2010

Subject Feelings of Energy and Focus (VAS scale)

- 13% significant difference in focus
- 12% difference in energy level at onset of exercise.
- 30% difference in focus after 10 min
- 60% difference in energy level.

Examination of Reaction Time and Subjective Feelings of Alertness, Energy and Focus

- High Energy Supplement
- Containing anhydrous caffeine, beta-alanine, vitamin C, evodiamine, N-acetyl-L-tyrosine, hordenine, 5-hydroxytryptophan, potassium citrate, N-methyl tyramine, sulbutiamine, vinpocetine, yohimbine HCL, and St. John's wort extract.
- Marketed as Redline™

Hoffman et al., 2009

Study protocol

Report to Human Performance Laboratory

10 min

Drink intake

Supplement or Placebo

10 min

T1
1. Questionnaire
2. Reaction Test
3. WAnT

10 min

T2
1. Questionnaire
2. Reaction Test
3. WAnT

10 min

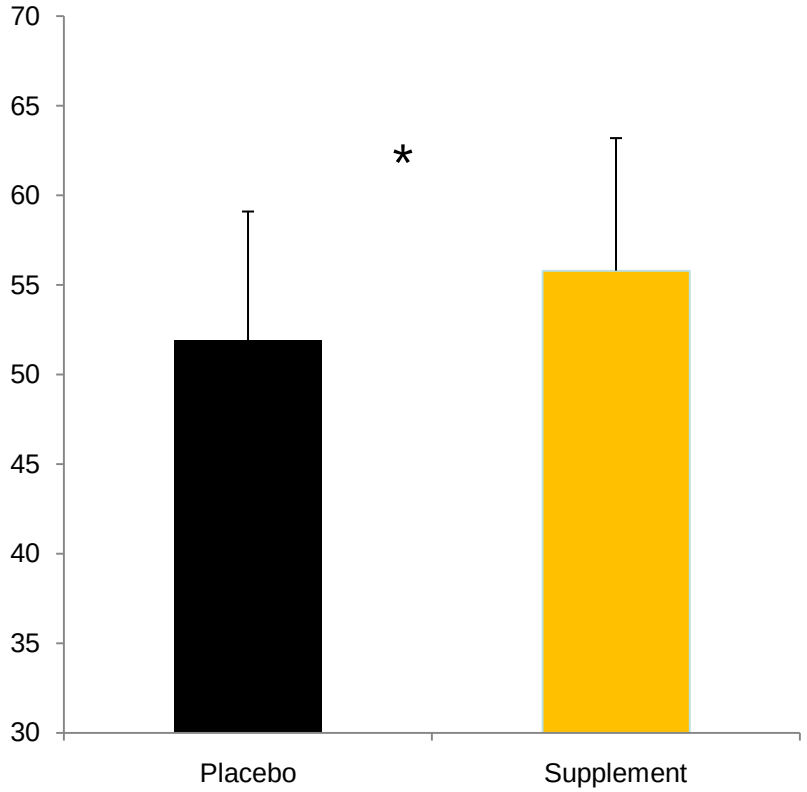
T3
1. Questionnaire
2. Reaction Test
3. WAnT

Response to Performance Questionnaire

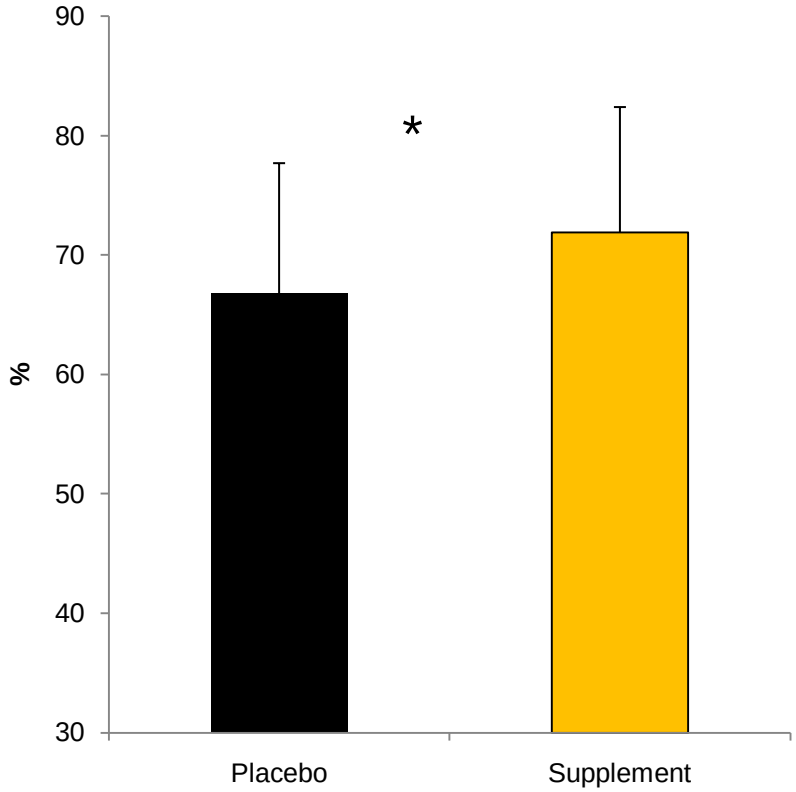
Question	Group	T1	T2	T3	AVG
My energy level is:	Sup	3.7 0.7	3.5 0.7	3.3 0.6	3.5 0.5 *
	PL	3.2 0.6	3.2 0.6	2.8 0.9	3.1 0.5
My fatigue level is:	Sup	2.3 0.9	2.8 0.8	3.1 0.7	2.7 0.6
	PL	2.4 0.7	3.1 0.5	3.3 0.9	2.9 0.5
My feeling of alertness is: P = 0.06	Sup	3.7 0.7	3.6 0.5	3.6 0.7	3.6 0.4
	PL	3.3 0.7	3.4 0.7	3.1 1.0	3.3 0.7
My feeling of focus for task is:	Sup	3.8 0.7	3.8 0.6	3.7 0.7 *	3.8 0.5 *
	PL	3.3 0.7	3.5 0.7	3.0 1.0	3.3 0.7

Reaction time

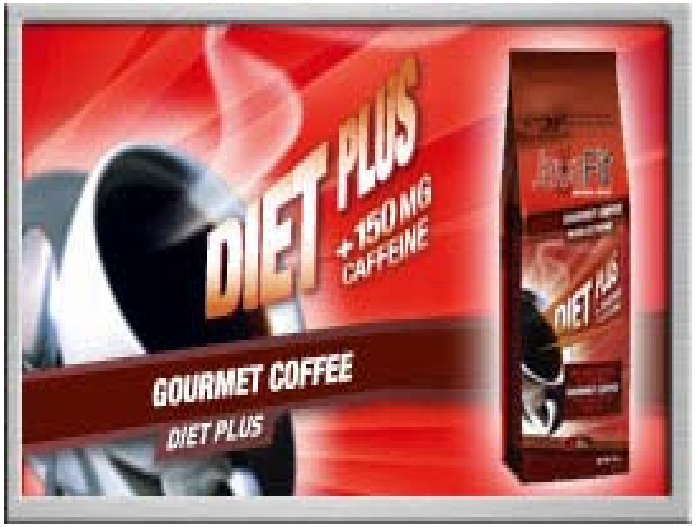
Average number of hits



Average percentage of successful hits from total possible targets



Effect of Nutritionally Enriched Coffee Consumption on Aerobic and Anaerobic Exercise Performance



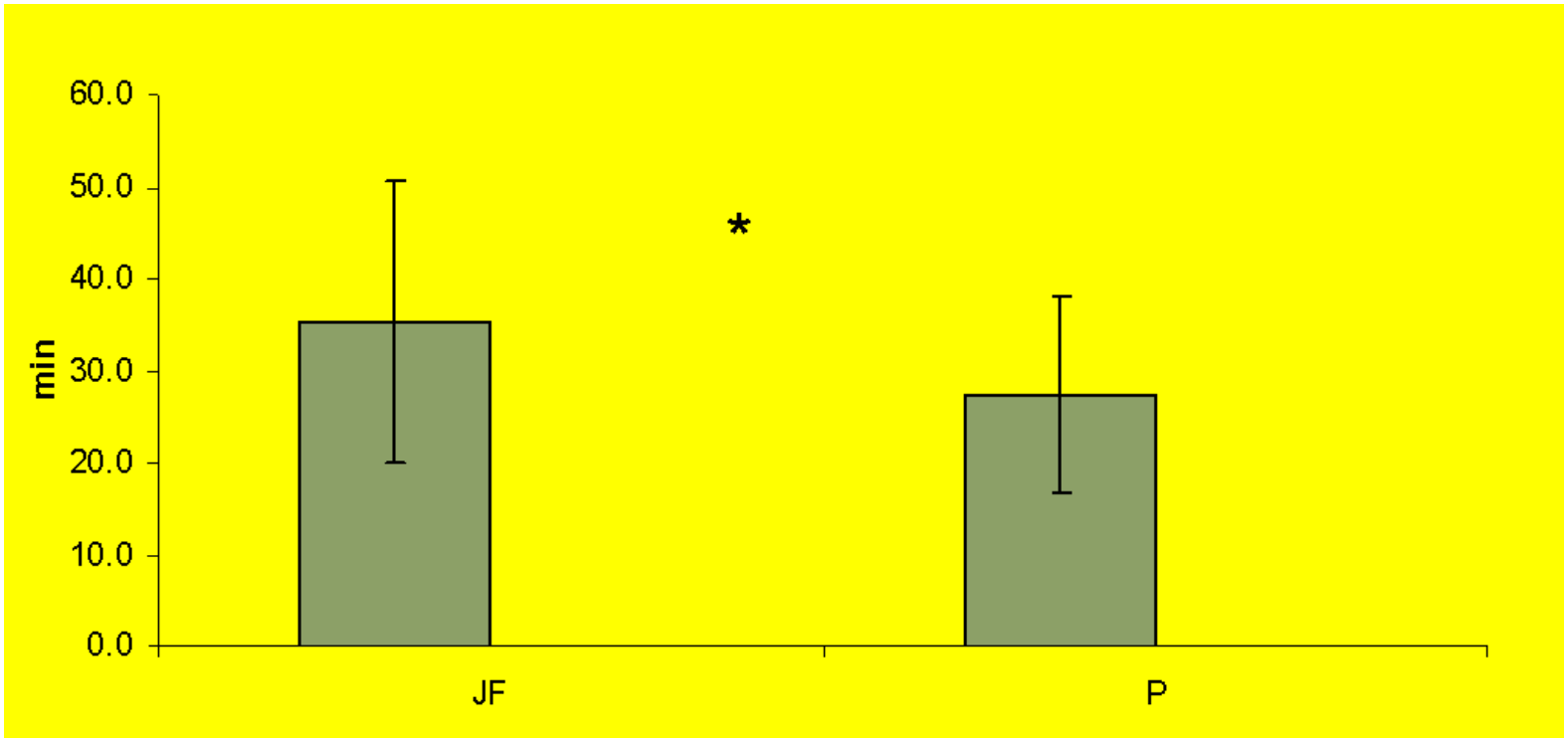
- Nutritionally enriched Coffee
  - 450 mg of caffeine
  - 1200 mg of garcinia cambogia
  - 360 mg of citrus aurantium extract
  - 225 mcg of chromium polynicotinate

- Compare1.5 cups of JavaFit coffee or Folgers Decaffeinated coffee.

- At 30 minutes post-consumption subjects performed either a cycle ergometer test at 70% of their VO2max or performed a 30-second Wingate Anaerobic power test.

Hoffman et al., J. Strength Cond. Res 2007

Time to Exhaustion



Anaerobic Power Measures

Group	PP (W)	MP (W)	PP ($W \cdot kg^{-1}$)	MP ($W \cdot kg^{-1}$)	TPP (s)	FAT ($W \cdot s^{-1}$)	TW (J)
P	917 ± 248	585 ± 100	12.6 ± 1.9	8.0 ± 0.8	4.06 ± 1.51	21.2 ± 8.0	17343 ± 3139
JF	929 ± 236	578 ± 105	12.8 ± 1.9	8.1 ± 0.9	4.48 ± 1.46	21.0 ± 7.6	17535 ± 2988

Summary

- Use of a ‘high energy’ sport drink consumed 10-minutes prior to exercise appears to enhance the training response.
- May enhance endocrine response to resistance exercise.
- May improve reaction time and focus to task.
- Important implications to both competitive and tactical athletes.

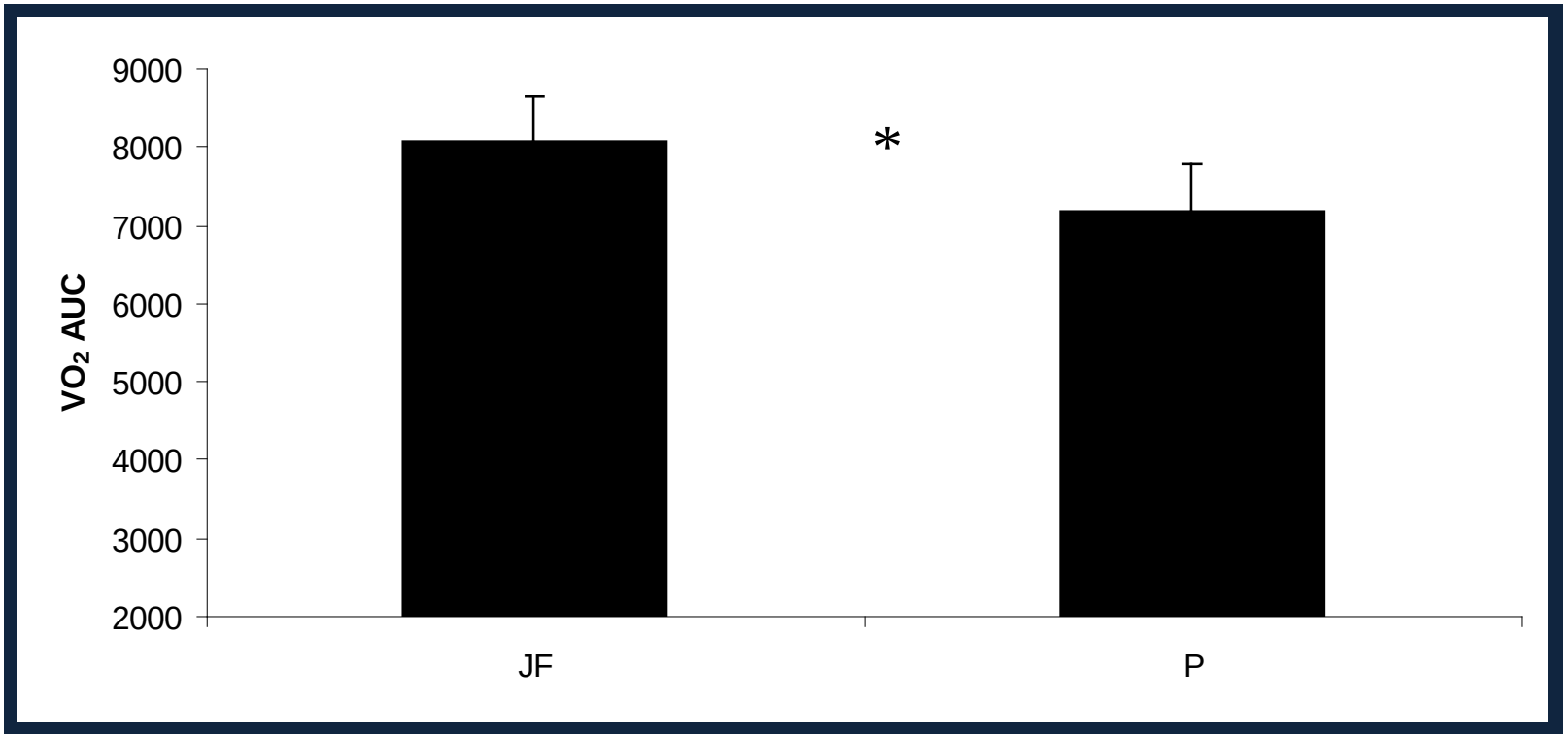
ENERGY DRINKS AS A THERMOGENIC SUPPLEMENTS

Nutritionally Enriched Coffee as an Energy Drink

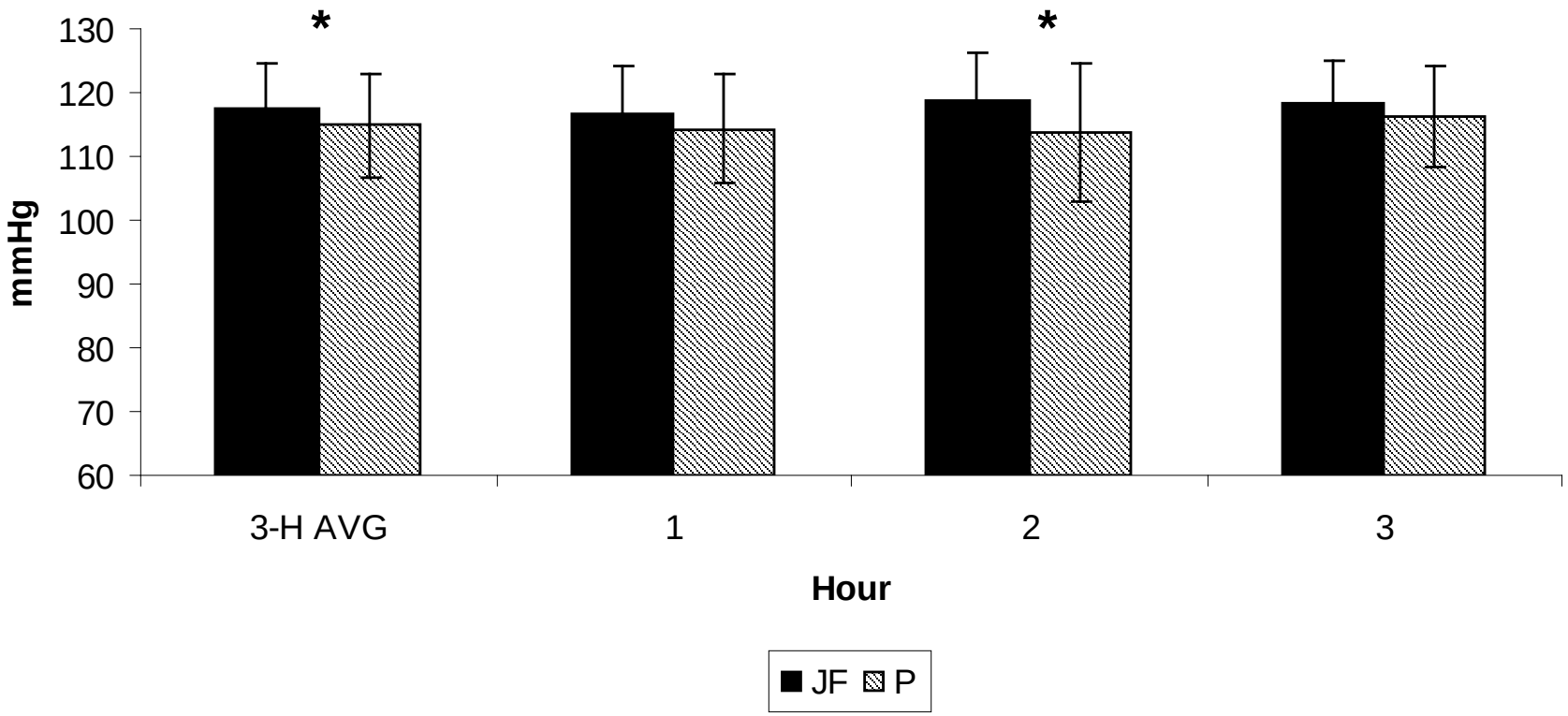
(Hoffman et al., JISSN, 2006)

- Ten physically active subjects (8 male, 2 female; age 20.9 1.7 y; height 178.1 10.4 cm; body mass 71.8 12.1 kg; VO_2max 51.9 8.7 ml·kg·min^{-1}) .
- Coffee was prepared by weighing out 15.6 g of either coffee and brewing it with 532 ml of water. Subjects were required to consume 1.5 cups (354 ml) of the coffee within 10 – 15 minutes.
  - 450 mg of caffeine
  - 1200 mg of garcinia cambogia
  - 360 mg of citrus aurantium extract
  - 225 mcg of chromium polynicotinate
- Measures made for 180 min following coffee consumption.

AUC Oxygen Consumption



Systolic Blood Pressure



Study Conclusion

- Consuming a nutritionally enriched coffee may provide enhanced metabolic rates in individuals that are sensitive (responders) to this caffeine and herbal combination.

Energy Drinks as Acute Thermogenic Agents: Recent Research

meltdown

Redline princess

A More Powerful Energy Drink

SUPPLEMENT FACTS

Serving Size 1/2 Bottle (4 FL OZ [120 mL])
Servings per Container 2

Calories 0	Amount per Serving	%DV*
Total Carbohydrates	0 g	0%
Total Fat	0 g	0%
Proprietary Blend †	Less than 20%	
Vitamin C (Ascorbic Acid)	†	25%
Potassium Citrate / Potassium Phosphate Dibasic	†	2%
Fat Catabolizer™ & β-3 Potentiator™	†	**
Caffeine Anhydrous	115 mg	**
a-MTTA (alpha-Methyl Tetradecylthioacetic Acid)	†	**
Yerba Mate Extract	†	**
Lipolytic Trigger™	†	**
3'-5'-cAMP (3'-5'-Cyclic Adenosine Monophosphate)	†	**
Super Synephrine™ β-3 Activator	†	**
Methyl-Synephrine HCl	†	**
Iphoric® Potent Methyl β-PEA Matrix	†	**
R-beta-Methylphenylethylamine	†	**
N-Methyl-beta-Phenylethylamine	†	**
NorEpiphex™ α2-Andrenergic Blockade Complex	†	**
Yohimbine HCl	†	**
11 - Hydroxy Yohimbine	†	**
alpha-Yohimbine	†	**
NorEpiphex™ M-MAOxidizor-I™	†	**
Hordenine HCl	†	**

* Percent daily values (DV%) are based on a 2000 calorie diet.
** Daily values not established.

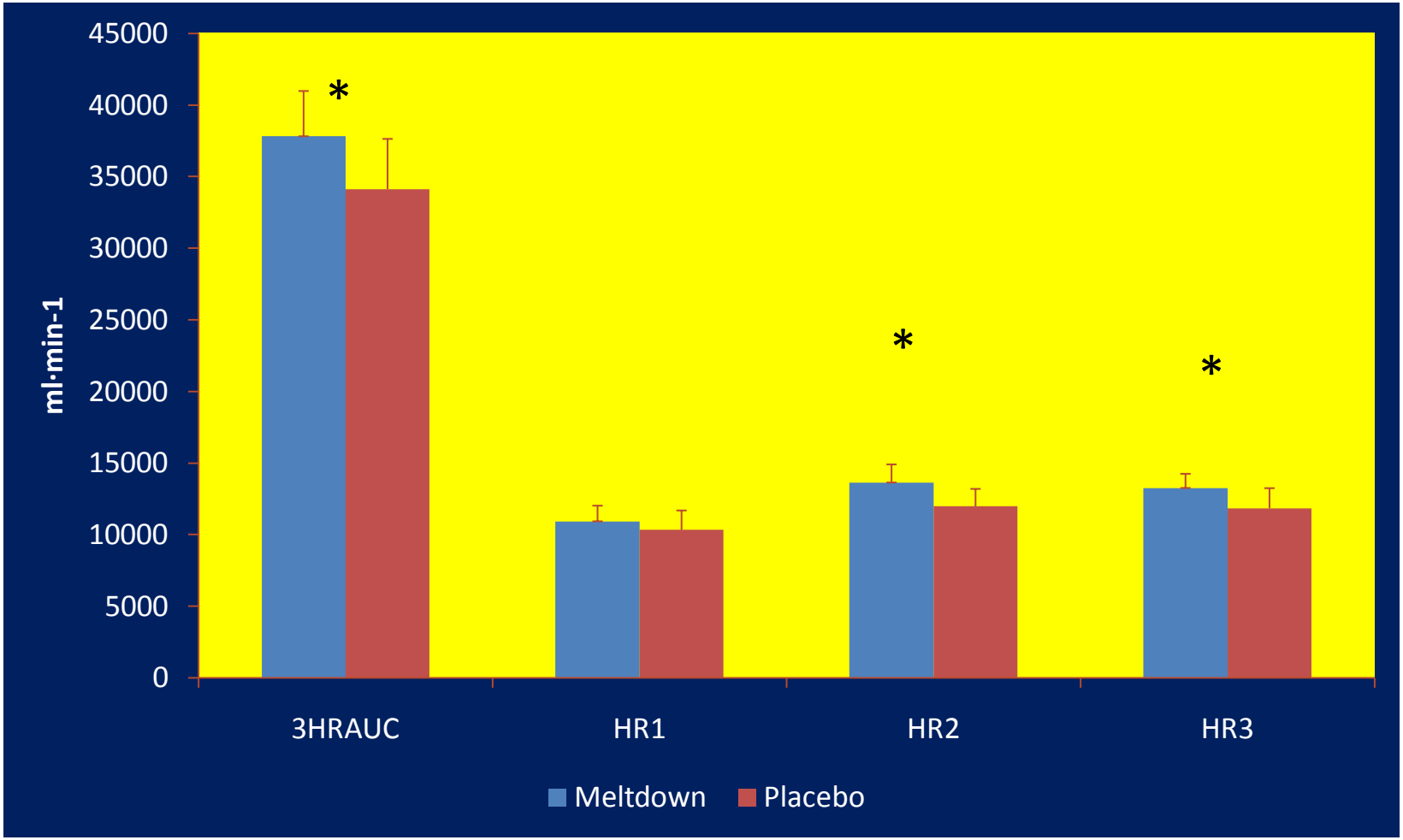
Additional Ingredients: Highly Purified Water, Citric Acid, Natural & Artificial Flavors, Sucralean® Brand Sucralose (a non-nutritive sweetener), Sodium Benzoate, Potassium Sorbate, Calcium Disodium EDTA.

CONTAINS NO FRUIT JUICE.

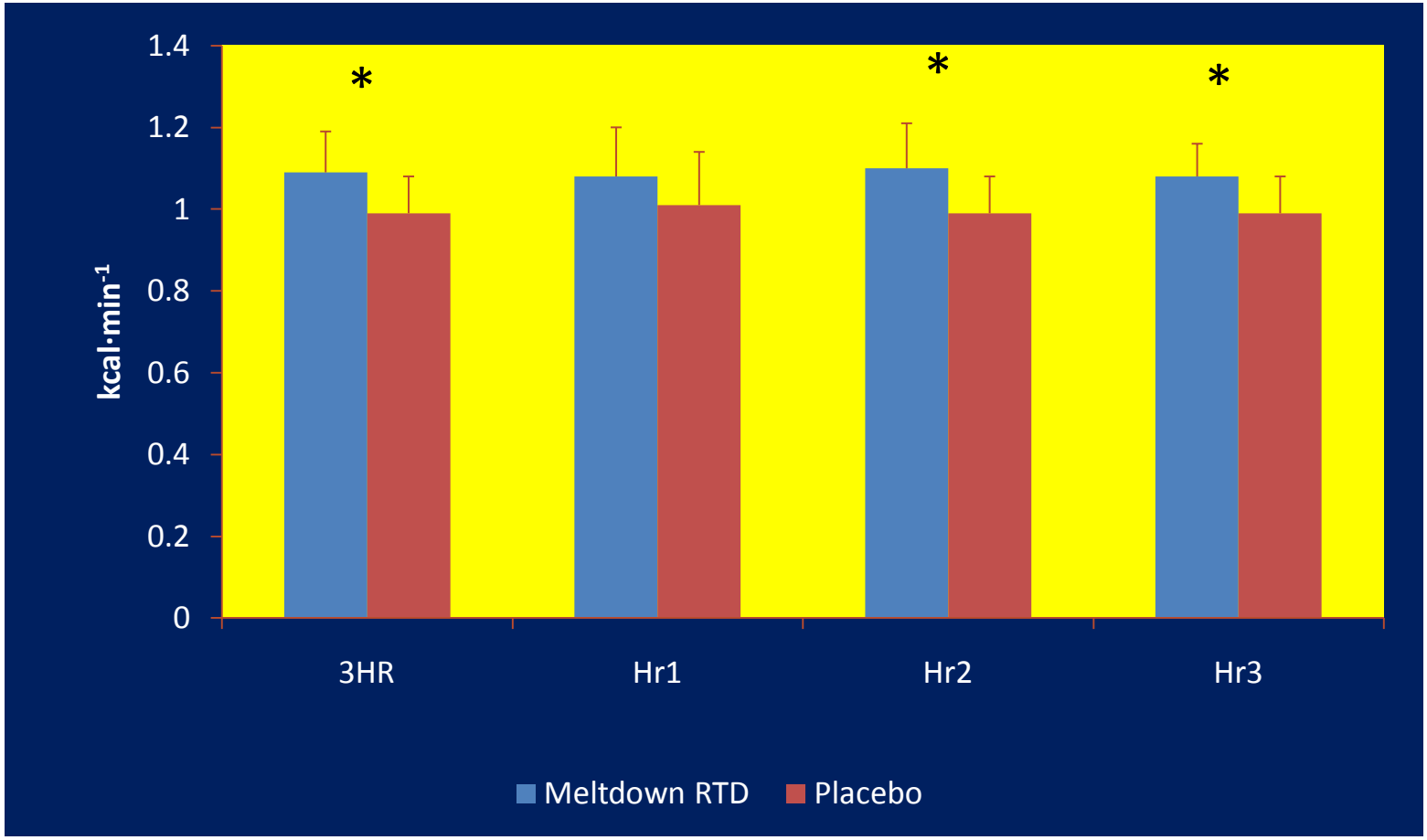
Thermogenic Effect of Meltdown RTD™ Energy Supplement in Young Healthy College Women

- Variables measured: resting oxygen consumption (VO_2), respiratory quotient (RQ), caloric expenditure (kcal), heart rate (HR), blood pressure (BP), and mood in healthy and physically active women.
- Ten female subjects (20.4 ± 0.70y; 166.9 ± 7.2 cm; 67.0 ± 7.0 kg; 29.6 ± 6.5% body fat): two testing sessions administered in a randomized and double-blind fashion.
- Provided either 140 ml (two 70 ml doses, separated by 30 min) of the supplement or placebo.
- Subjects then rested in a semi-recumbent position for three hours.

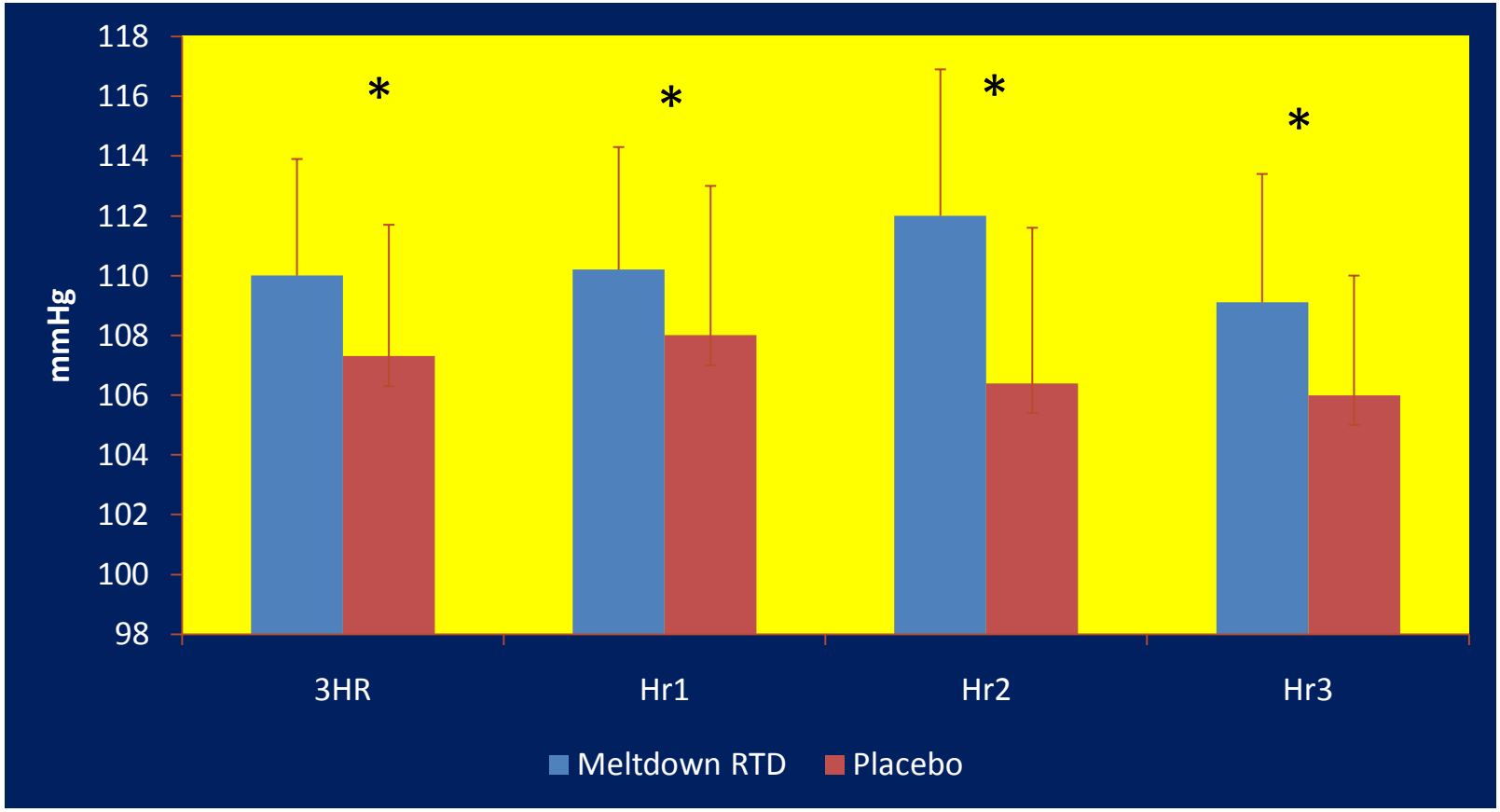
AUC Oxygen Consumption



Average Energy Expenditure



Systolic Blood Pressure

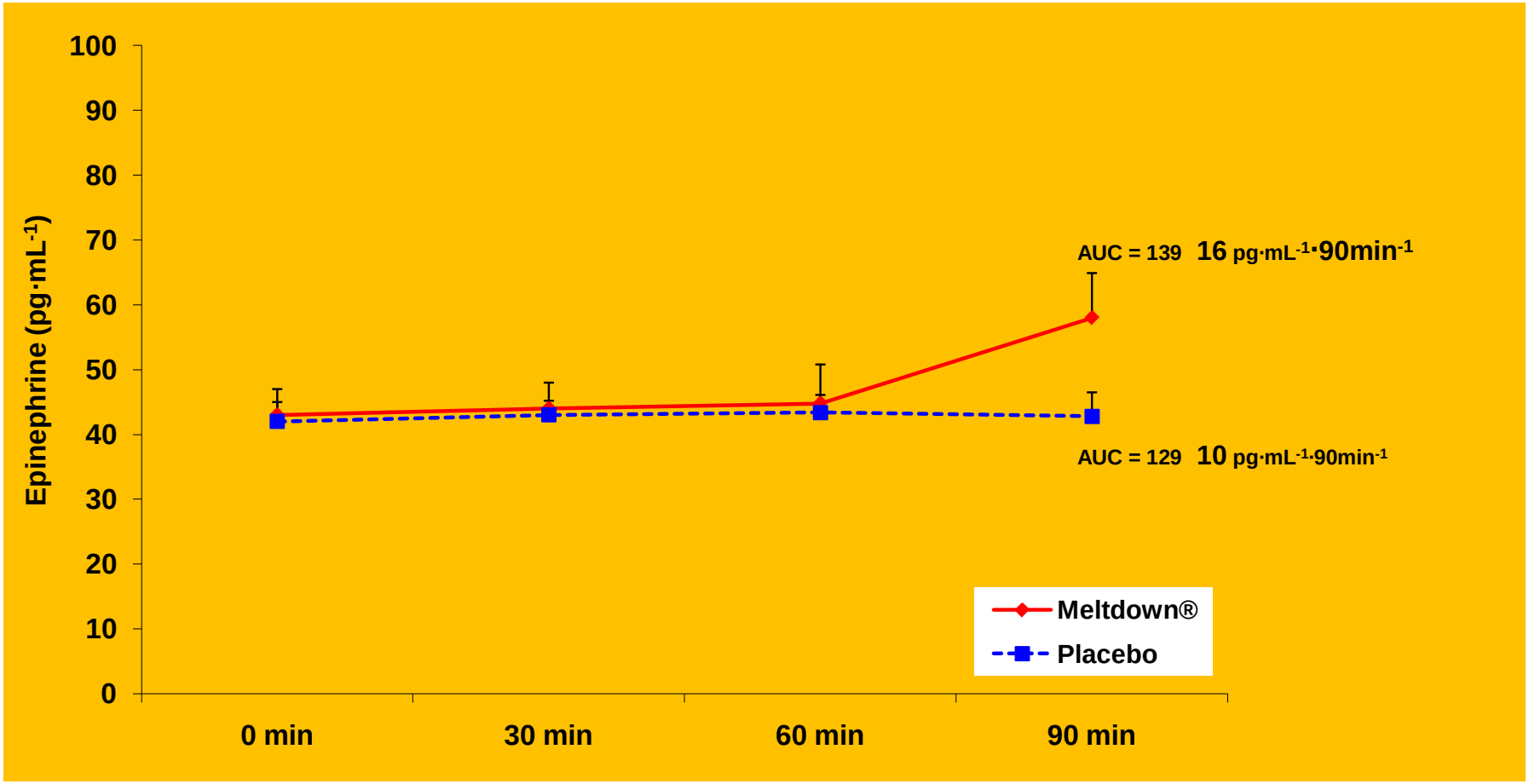


Effect of Meltdown® on Catecholamine and Markers of Lipolysis in Resistance Trained Men

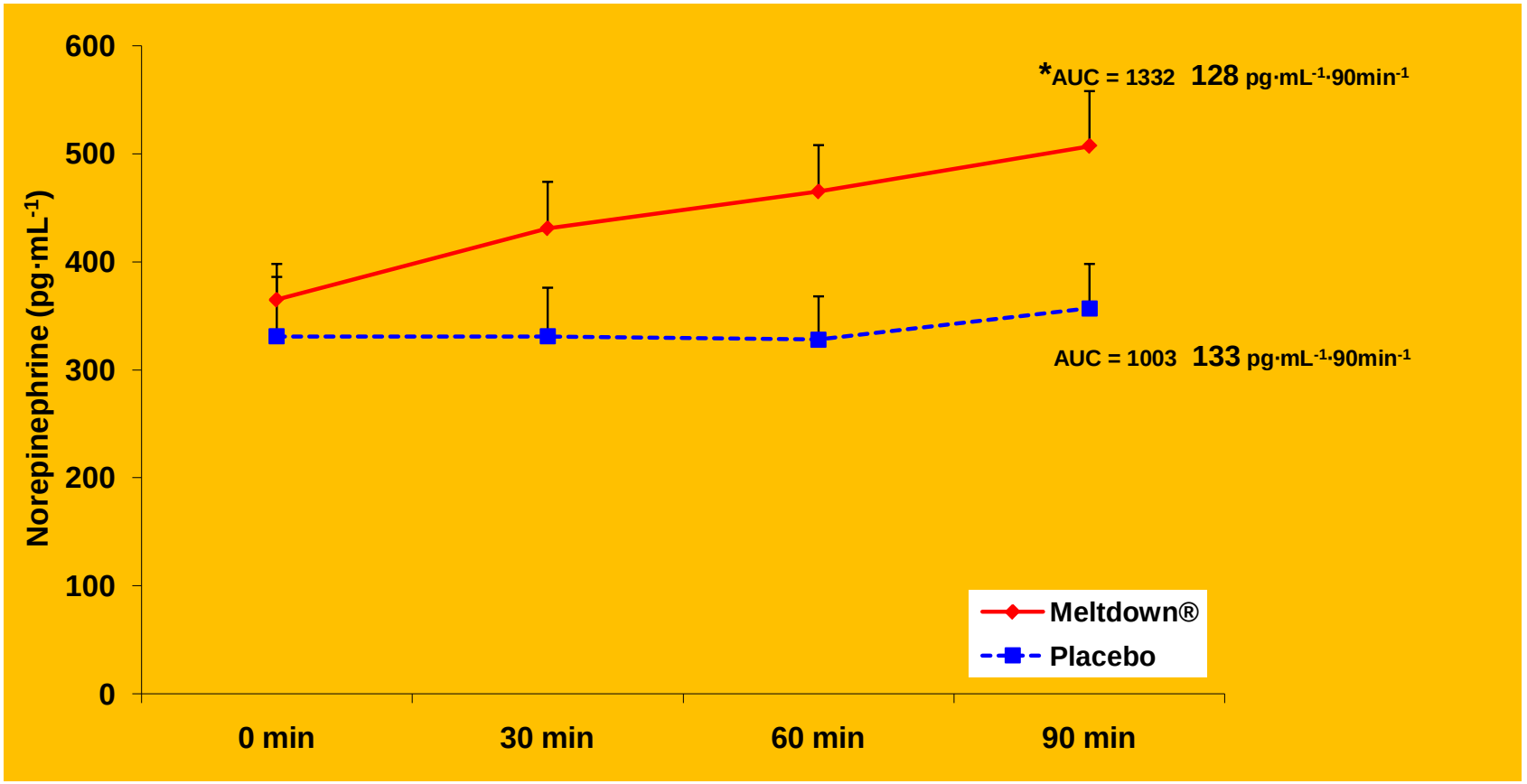
(Bloomer et al., 2009)

- In comparison to placebo, Meltdown® *(at the recommended dosage)* results in:
  - Increased energy expenditure
  - Increased fat oxidation
  - Increased blood norepinephrine
  - Increased blood epinephrine
  - Small increase in heart rate (4-6 bpm) and blood pressure (6-10mmHg)
- For all variables, results are long lasting (several hours post ingestion)
- Subject variability in response

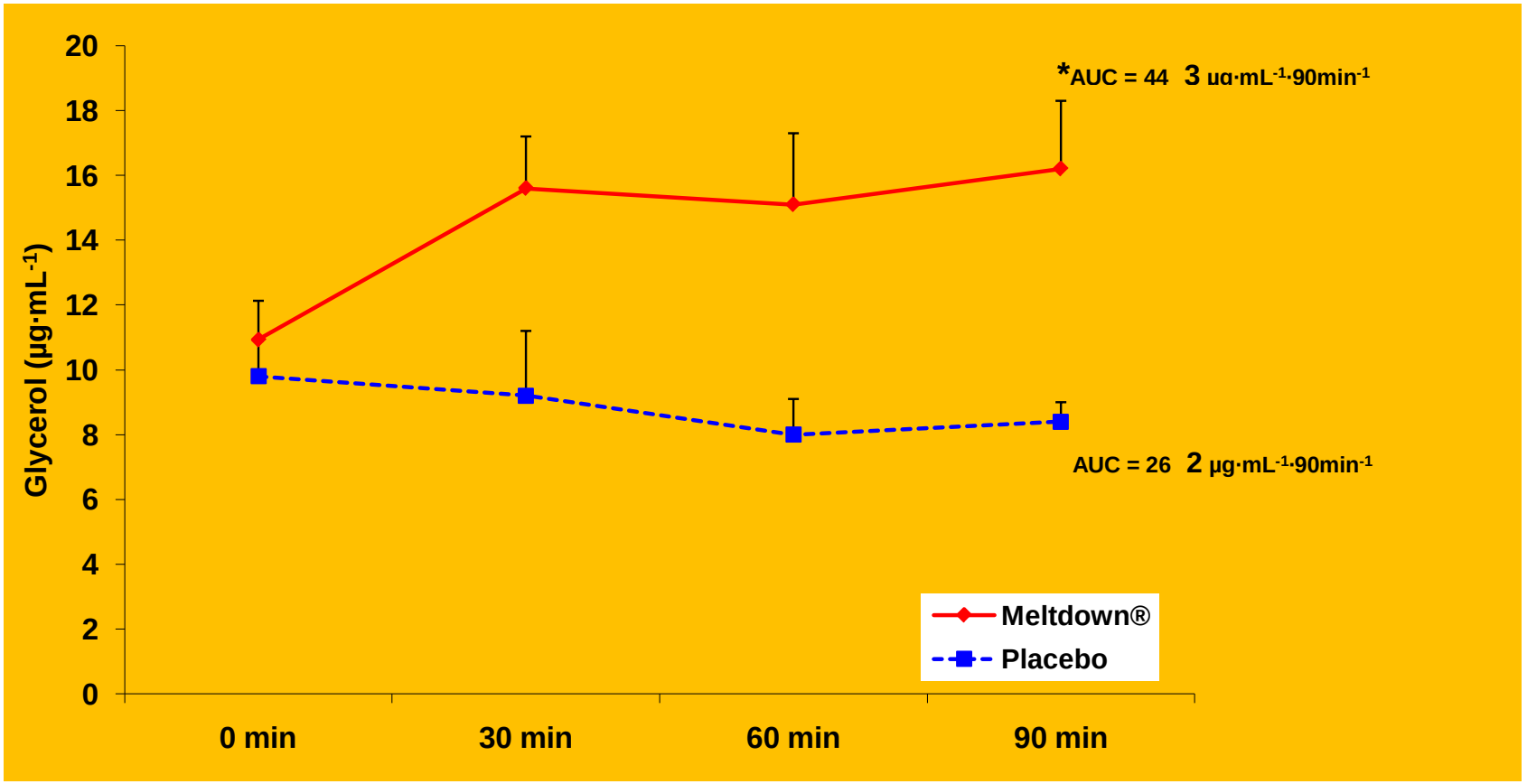
Epinephrine



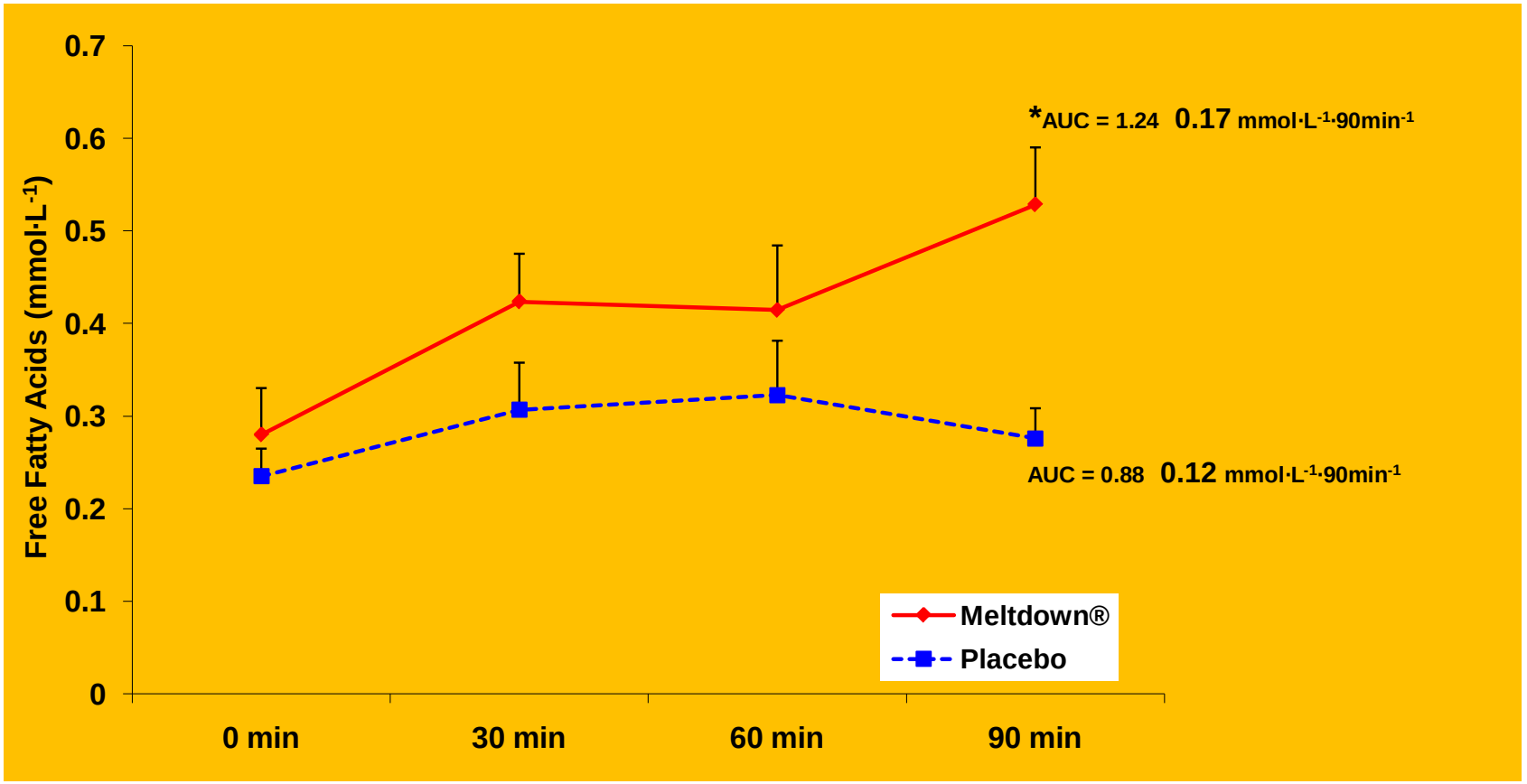
Norepinephrine



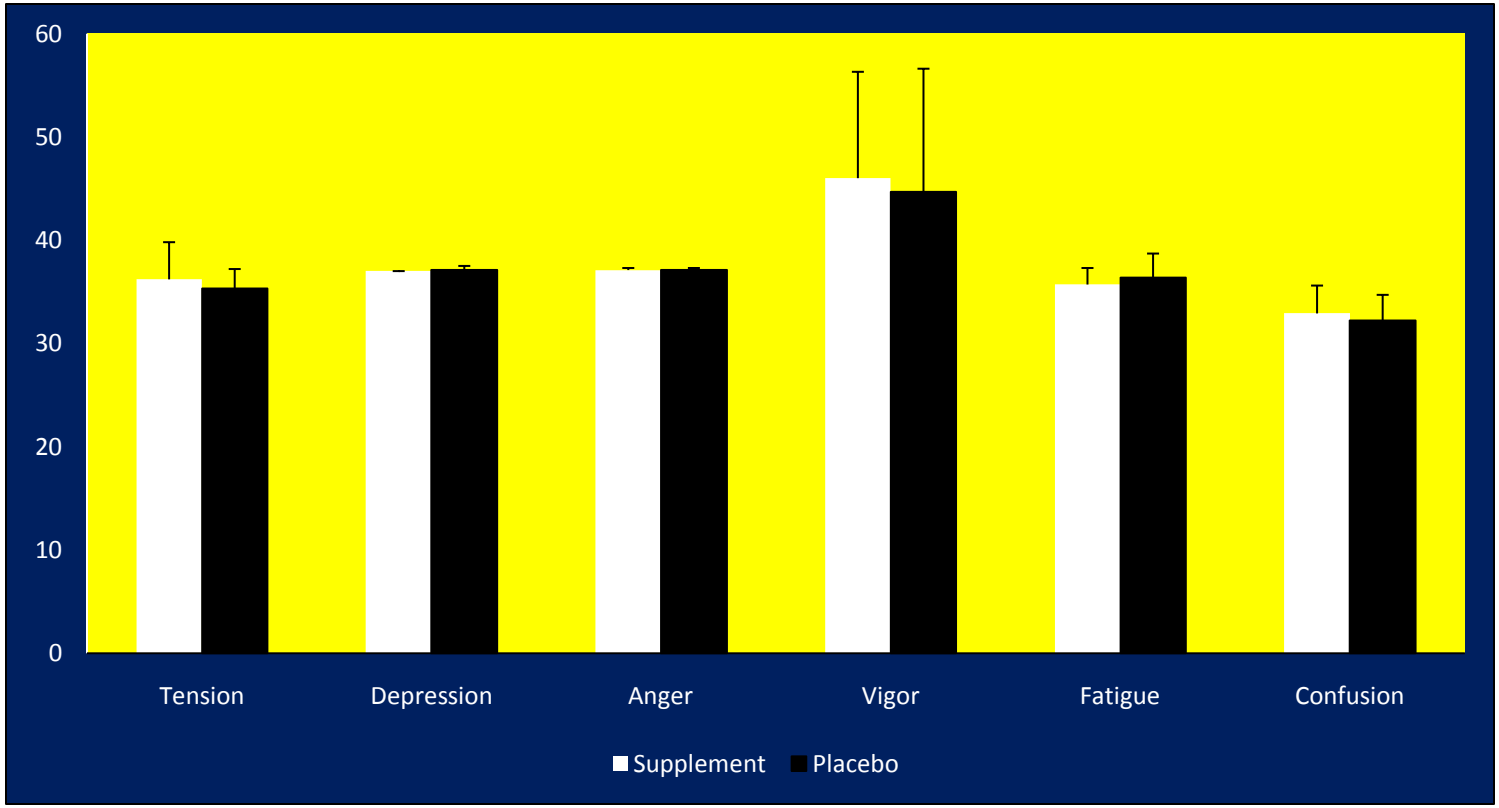
Glycerol


20
18
16
14
12
10
8
6
4
2
0
Glycerol (µg·mL-1)
*AUC = 44 3 µg·mL-1·90min-1
AUC = 26 2 µg·mL-1·90min-1
Meltdown®
Placebo
0 min
30 min
60 min
90 min

Free Fatty Acids



Mood States (Meltdown® RTD)



No change in 3 hours or within each hour examined

CREATINE SUPPLEMENTATION

Creatine Supplementation

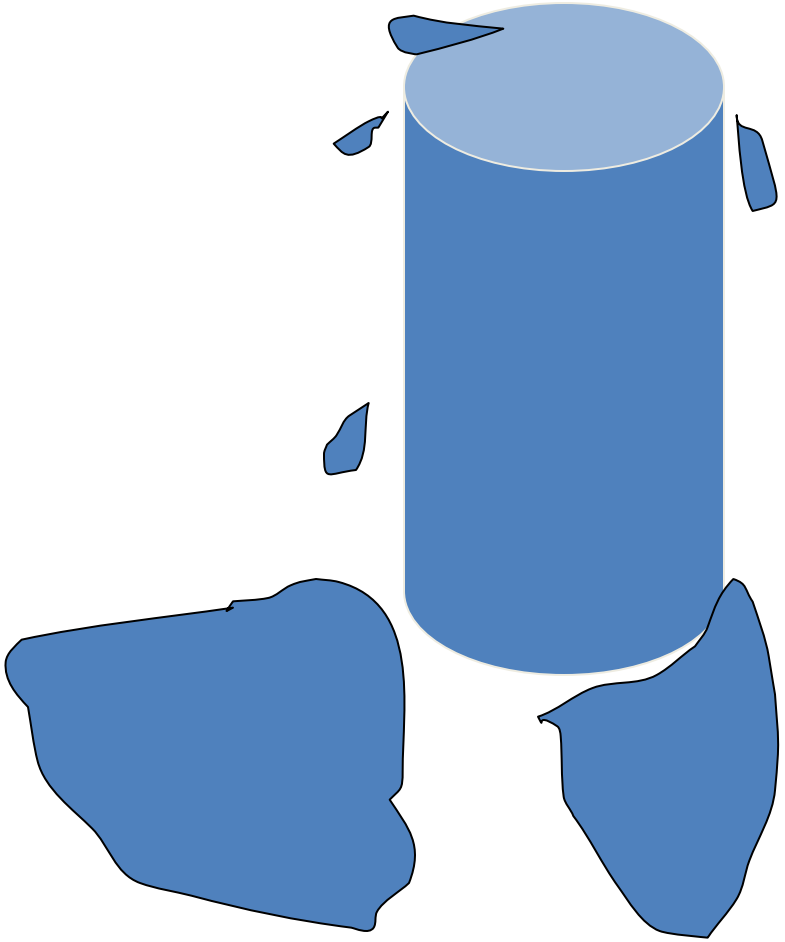
- One of the leading sport supplements used by strength power athletes today.
- 48% of American male collegiate athletes (up to 80% in some sports) use or have used creatine during career.
- Use in American high school athletes (90% of those that supplement)

Physiological Role of Phosphocreatine in Muscle

- Rephosphorylates ADP to ATP during short duration, high intensity exercise.
- Enhances transport capacity of high energy phosphates to sites of ATP utilization.
- Synthesized naturally in the body primarily by the liver, and in smaller amounts in kidney and pancreas.
- Creatine can also be obtained from dietary sources (meat and fish).
- 98% of creatine stored with muscle.

Creatine Supplementation

- May increase creatine concentration within muscle by 5 - 30%.
- Significant intra-subject variability.
- There does appear to be a saturation limit.
- Important implications for the more is better theory.



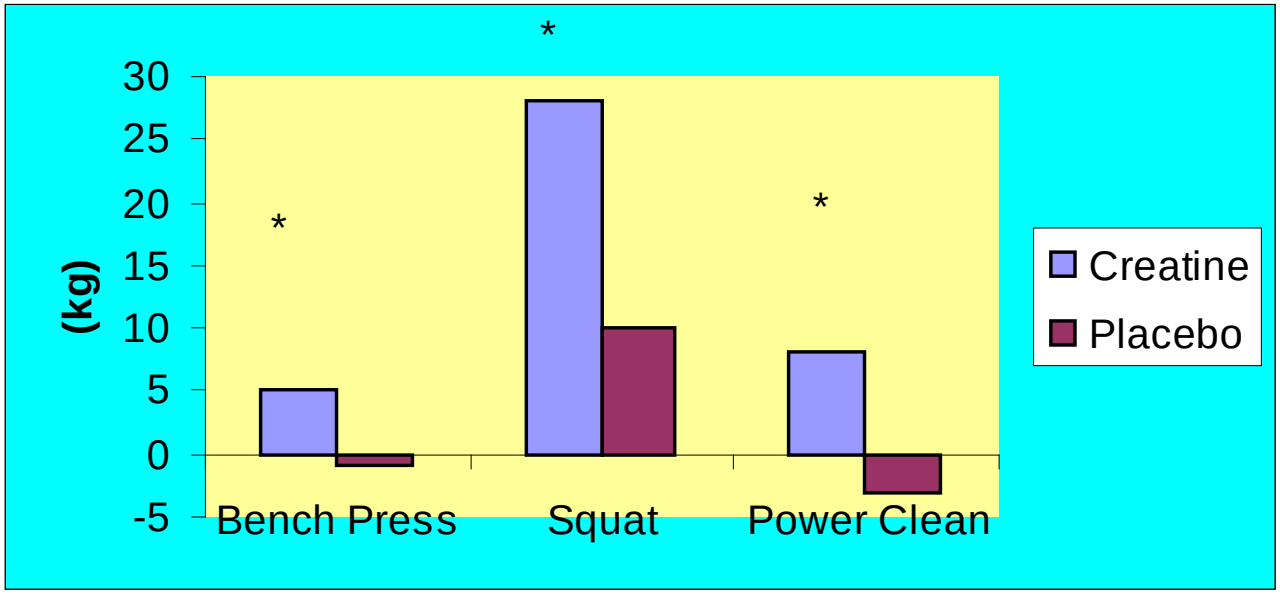
Creatine Supplementation

- Typical supplementation regimen:
  - loading dose of 20-25 g daily for 5-days.
  - maintenance dose of 2 g per day.
- Can bypass loading dose, but will take longer to reach same muscle creatine concentrations (30 days versus 5 days).
- As long as maintenance dose is taken, muscle creatine concentrations will remain elevated.
- Once supplementation stops, muscle creatine concentrations return to baseline in about 4 weeks.

Creatine Supplementation and Athletic Performance

- Most widely studied ergogenic aid in the past few years.
- Athletes that rely primarily on the phosphagen system (e.g. bodybuilders, power lifters, sprinters, football players) would appear to benefit the most.
- Studies have consistently shown significant ergogenic benefits.

Effect of Creatine Supplementation on Muscle Strength Gain

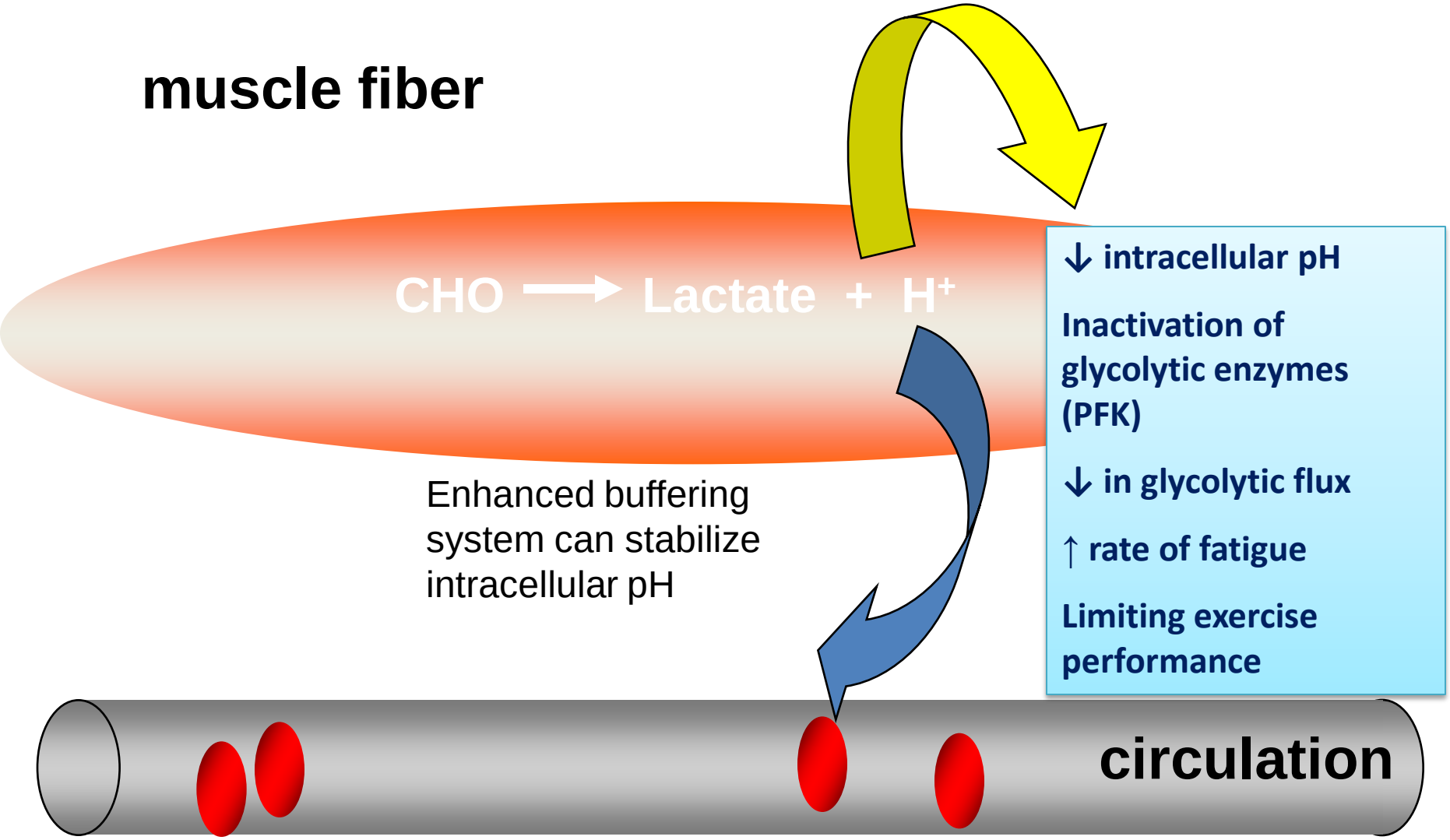


- Division I football players
- No loading phase
- 10 week study

Pearson et al., 1999

BETA-ALANINE

Histidine Dipeptides



Histidine Dipeptides

- Non-bicarbonate buffering in skeletal muscle primarily occurs via the imidazole groups on histidine residues.
- Carnosine, Anserine and Balenine are histidine containing dipeptides found in various vertebrate muscle cells.
- pK values are close to physiological pH

Substance	p*K*
Typical histidyl-imidazole in proteins	6.5 (25°C)
adjacent to acidic (–) group	7-8 (25°C)
adjacent to basic (+) group	5-6 (25°C)
L-Histidine	6.21 (20°C)
Carnosine	7.01 (20°C)
Anserine	7.15 (20°C)
Balenine	6.93 (20°C)
Inorganic orthophosphate	6.88 (20°C)

Histidine Dipeptides

400 mmol/kg dry muscle

110 mmol/kg dry muscle

17 - 25 mmol/kg dry muscle

90 mmol/kg dry muscle

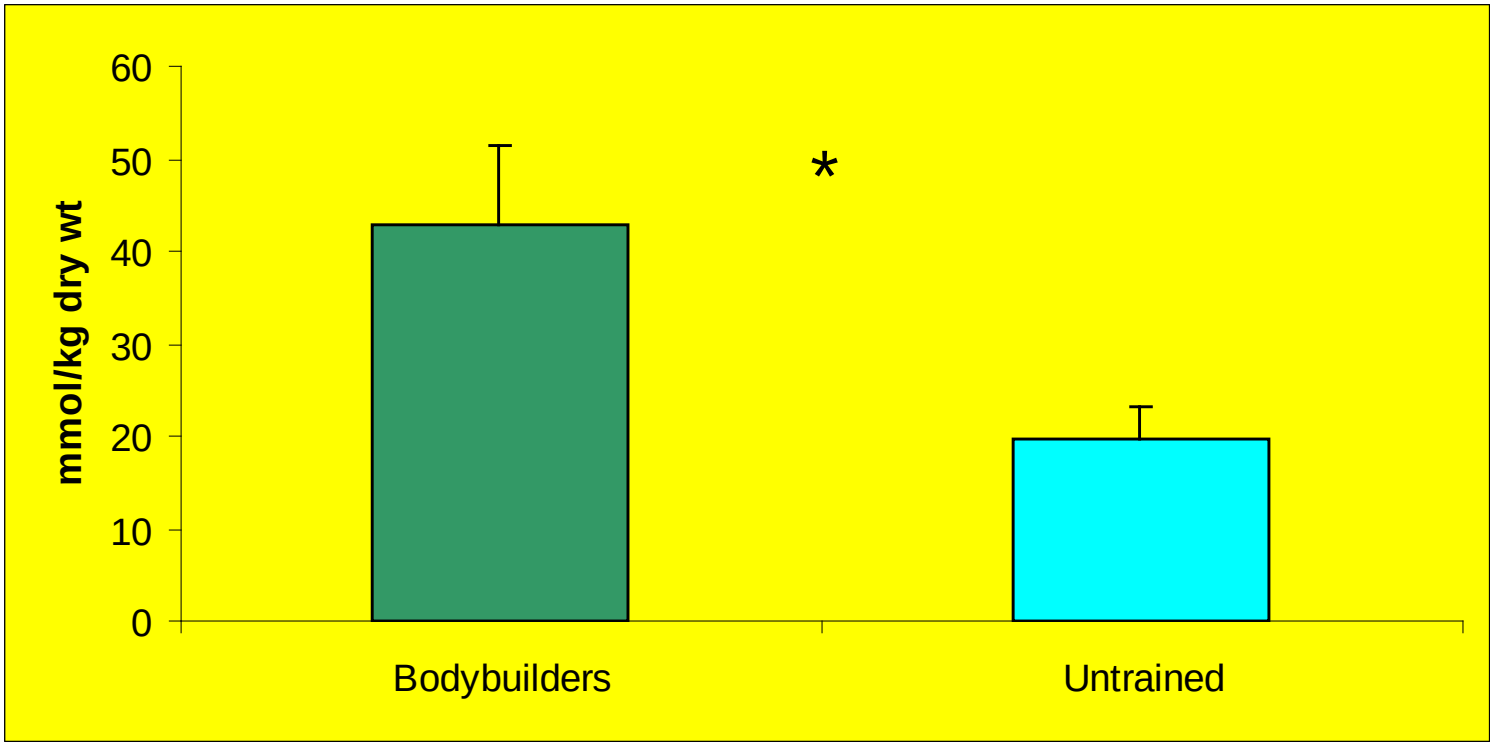
Histidine Dipeptides

- Anserine and balenine are found in animal tissues, but not in human.
- Carnosine is found in human skeletal muscle.
- Free histidine is found but is a poor buffer over the physiological pH range

(Harris et al., 2006).

TRAINING EFFECTS

Tallon et al.: The carnosine content of vastus lateralis is elevated in resistance trained bodybuilders *J Strength & Cond Res., 2005*



Disparity between bodybuilders and untrained men are too great to be explained by a difference in fiber composition

Carnosine and β-Alanine: What's the Connection?

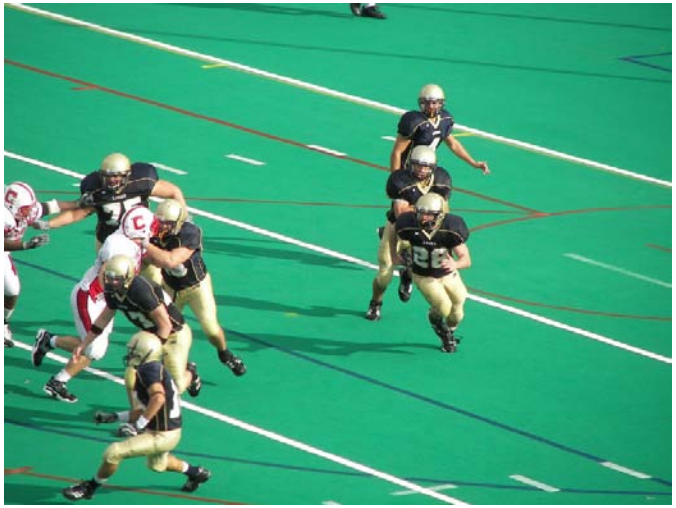
- Two precursors to carnosine are β-alanine and histidine.
- Histidine: nonessential amino acid, high concentration in skeletal muscle with carnosine synthetase.
- Likely not limiting to carnosine synthesis!
- In contrast, β-alanine is found in very low concentrations in muscle and is likely rate limiting to carnosine synthesis!

ß-alanine

- A non-proteogenic amino acid synthesized naturally in liver.
- Increases **carnosine** concentrations within skeletal muscle.
- Carnosine has been shown to enhance the buffering capacity during high intensity exercise
- 4 weeks of supplementing β-alanine (4 to 6 grams per day) resulted in a mean increase of 64% in skeletal muscle (Harris et al., 2006)
- May provide an additive ergogenic effect when combined with creatine alone
  - Reduce the rate of fatigue in muscle providing for a greater training stimulus.
  - Enhancing muscle's ability to withstand the fatiguing effects of high intensity exercise.

Research on Beta-alanine

- Compare the effects of creatine + ß-alanine to creatine alone on strength, power and body compositional changes during a 10-week resistance training program in collegiate football players.
  - Hoffman et al., Int J Sport Nutr. Metab., 2006



Methods

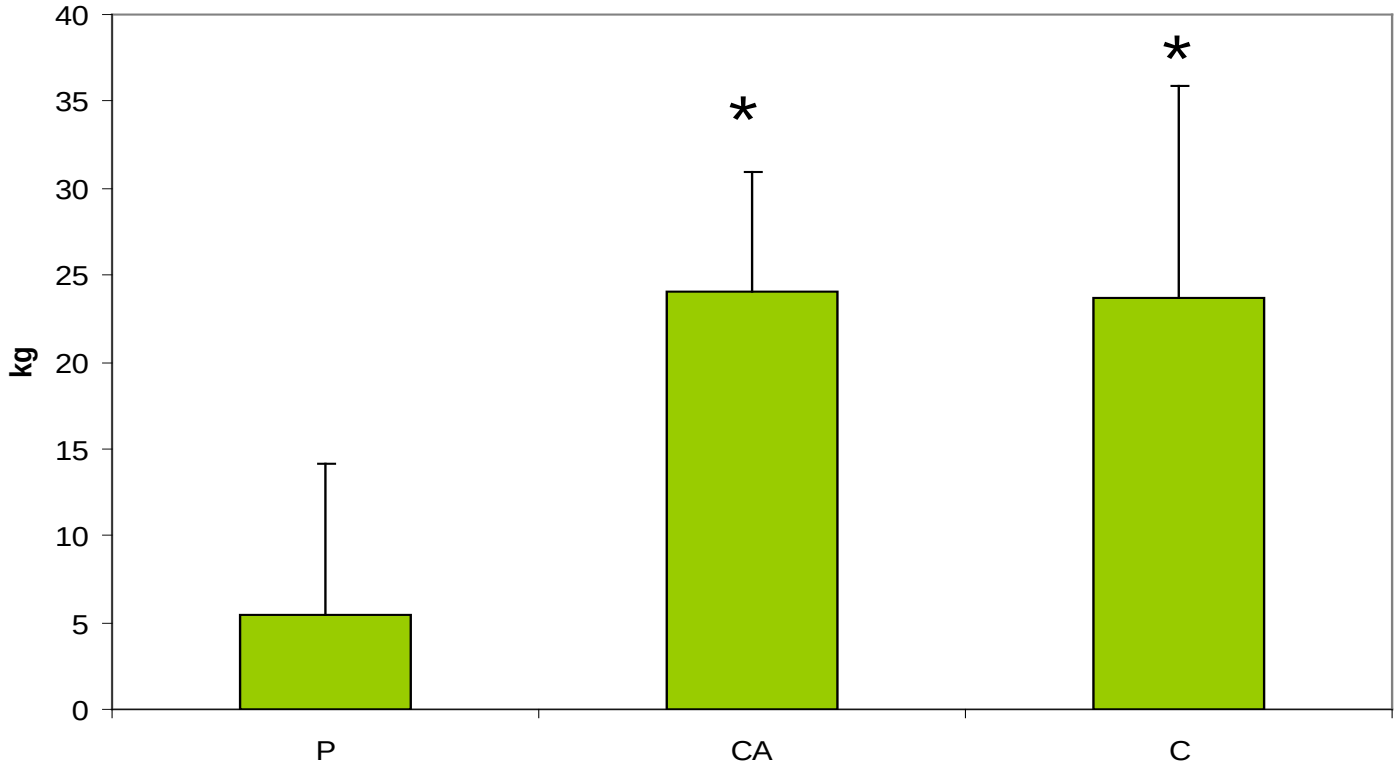
- 33 collegiate football players
- Three groups
  - CA: creatine + ß-alanine supplementation (10.5 g·d-1 of creatine monohydrate and 3.2 $g \cdot d^{-1}$ of ß-alanine),
  - C: creatine only (10.5 $g \cdot d^{-1}$ of creatine monohydrate)
  - P: placebo (10.5 $g \cdot d^{-1}$ of dextrose).
- Double blind format
- All subjects 4 day per week split routine
- 10-week periodized training program

Dietary Analysis and Body Composition

	P	CA	C
	200 – 1000 kcal lower than studies reporting sign ↑ in BM		
Caloric Intake (kcal)	2991 ± 809	3222 ± 856	2999 ± 546
Δ Body Fat %	0.25 ± 1.53	**-1.21 ± 1.12***	-0.69 ± 0.88
Δ Lean Body Mass (kg)	-0.44 ± 1.62	**1.74 ± 1.72***	0.61 ± 1.72
Δ Fat Mass (kg)	0.21 ± 1.96	-1.06 ± 1.12	-0.39 ± 1.24

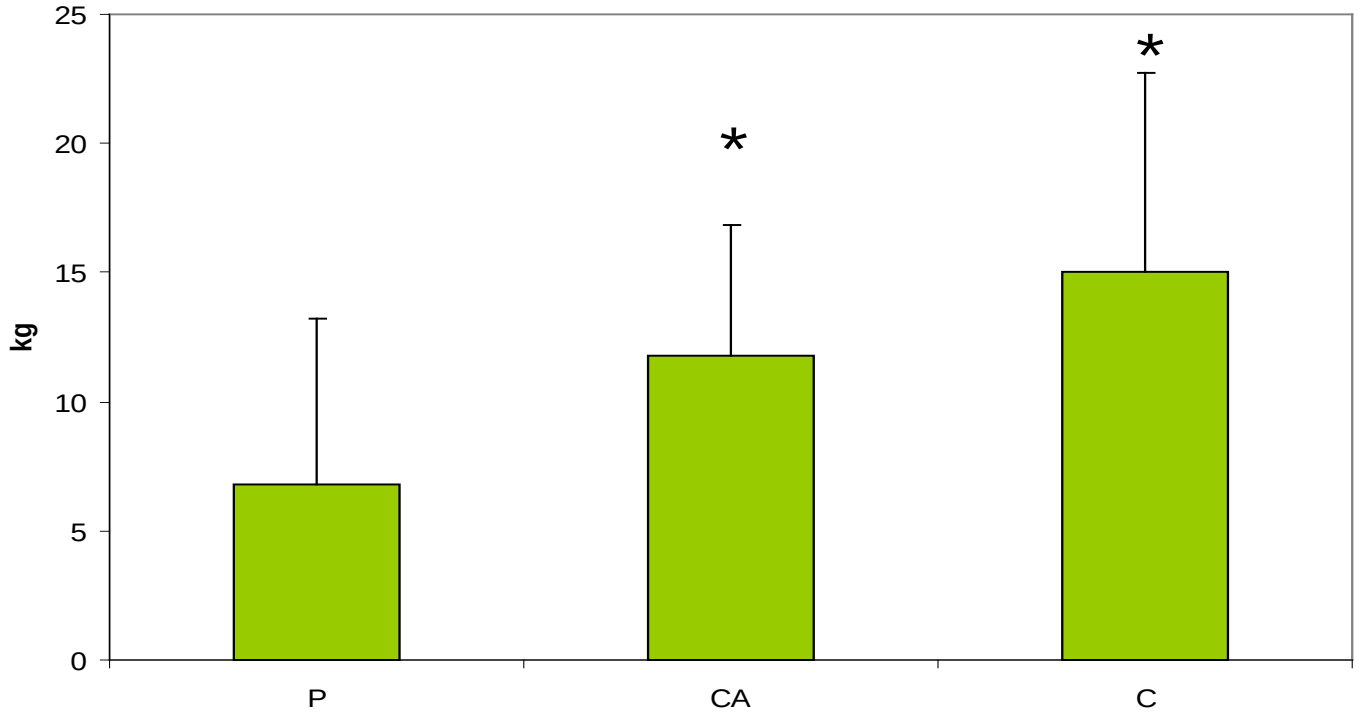
* = $P < 0.05$ between CA and P

Δ 1-RM Squat Strength



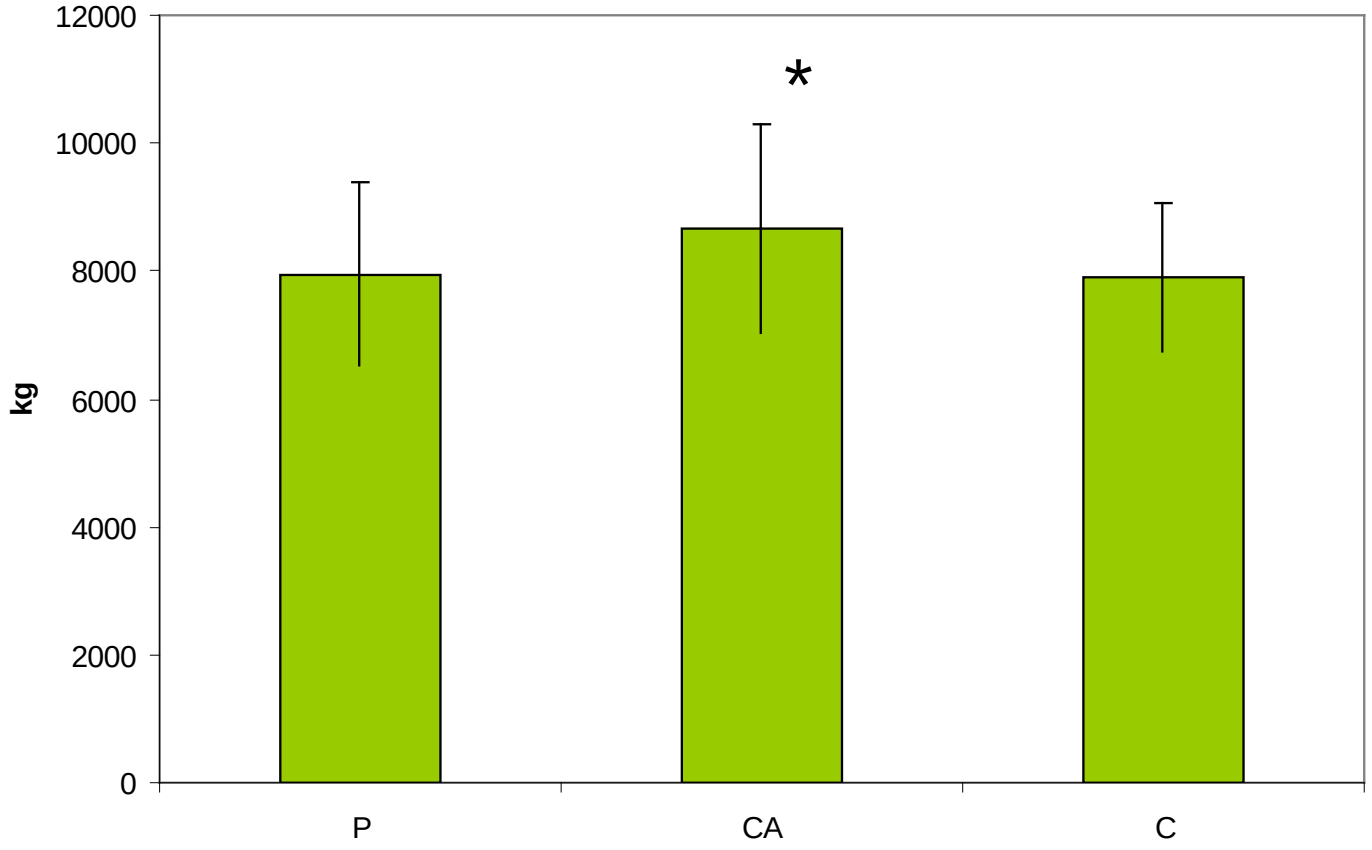
* p < 0.05 from P

Δ 1-RM Bench Press Strength



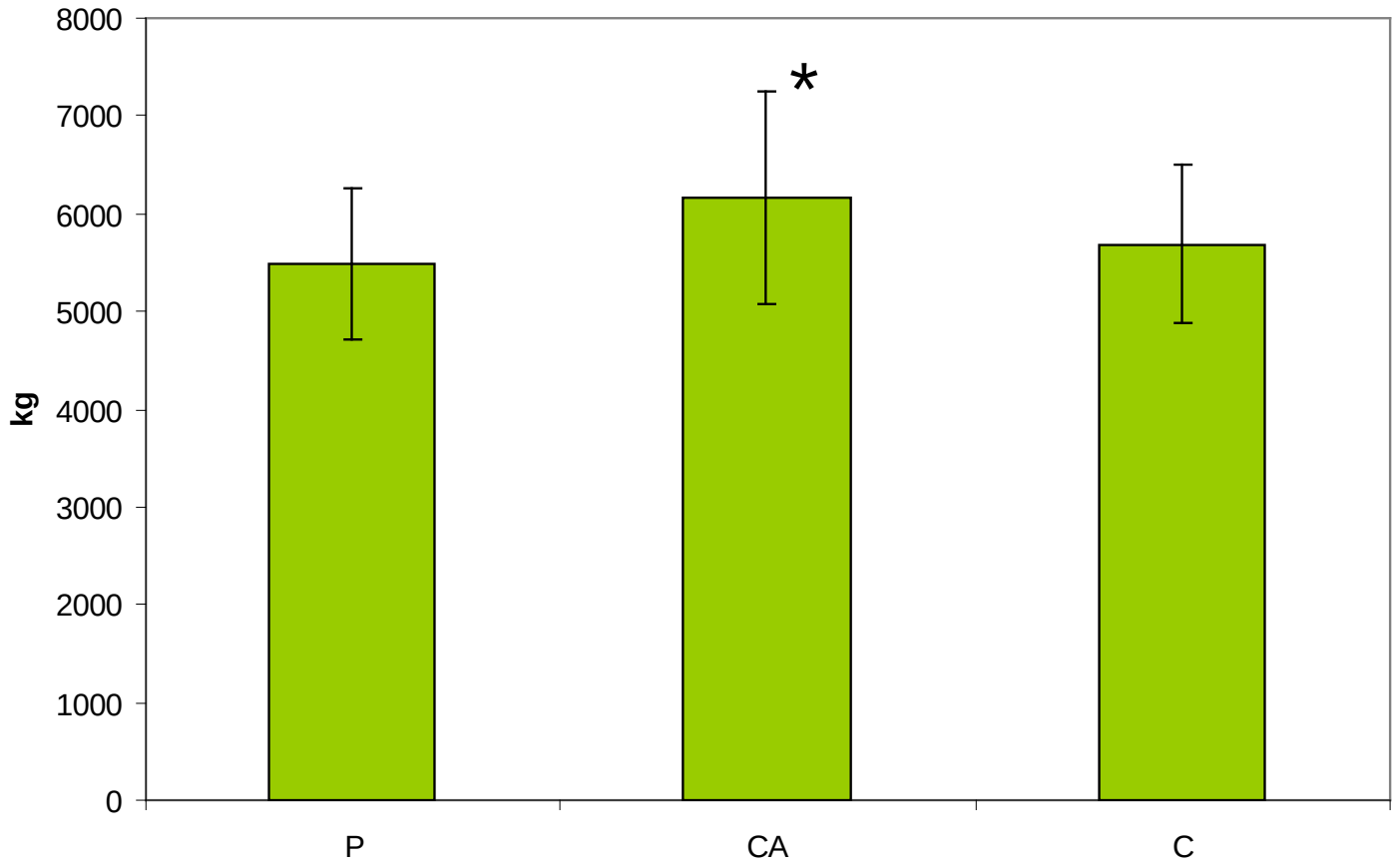
* p < 0.05 from P

Average Weekly Training Volume
Squat Exercise



* p < 0.05 from P

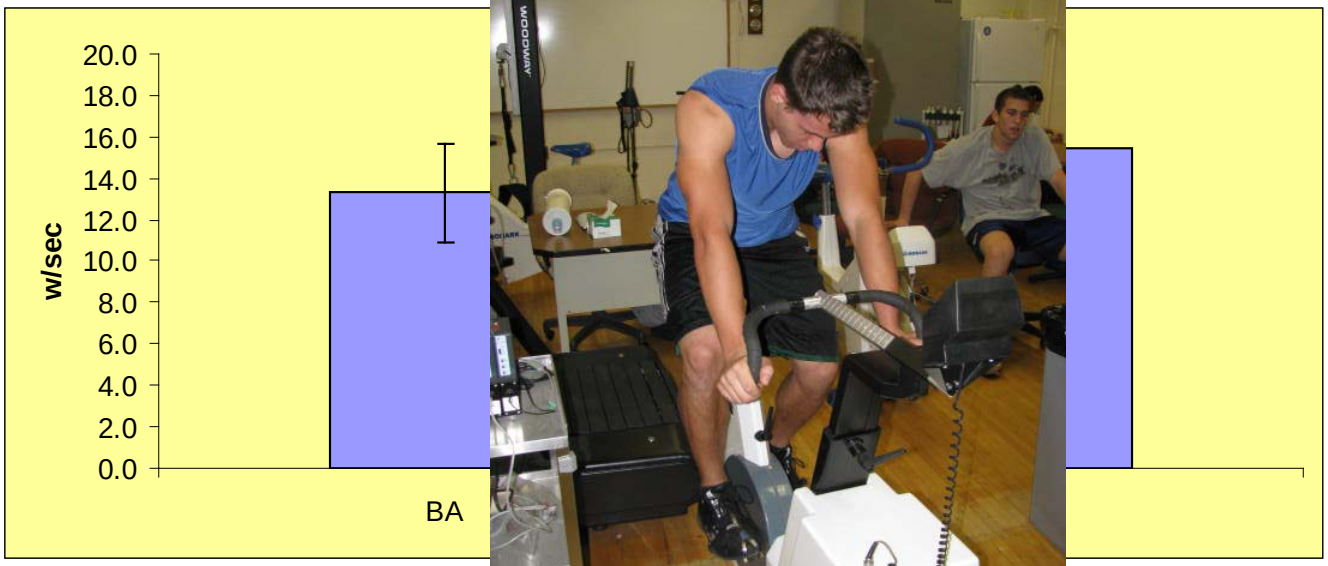
Average Weekly Training Volume
Bench Press Exercise



* p < 0.05 from P

Short Duration β-Alanine Supplementation Increases Training Volume and Reduces Subjective Feelings of Fatigue in College Football Players (Hoffman et al., Nutr. Res, 2008)

- 2 weeks of 4.8 g / day of β-alanine.
- Supplementation continued for an additional 2 weeks.

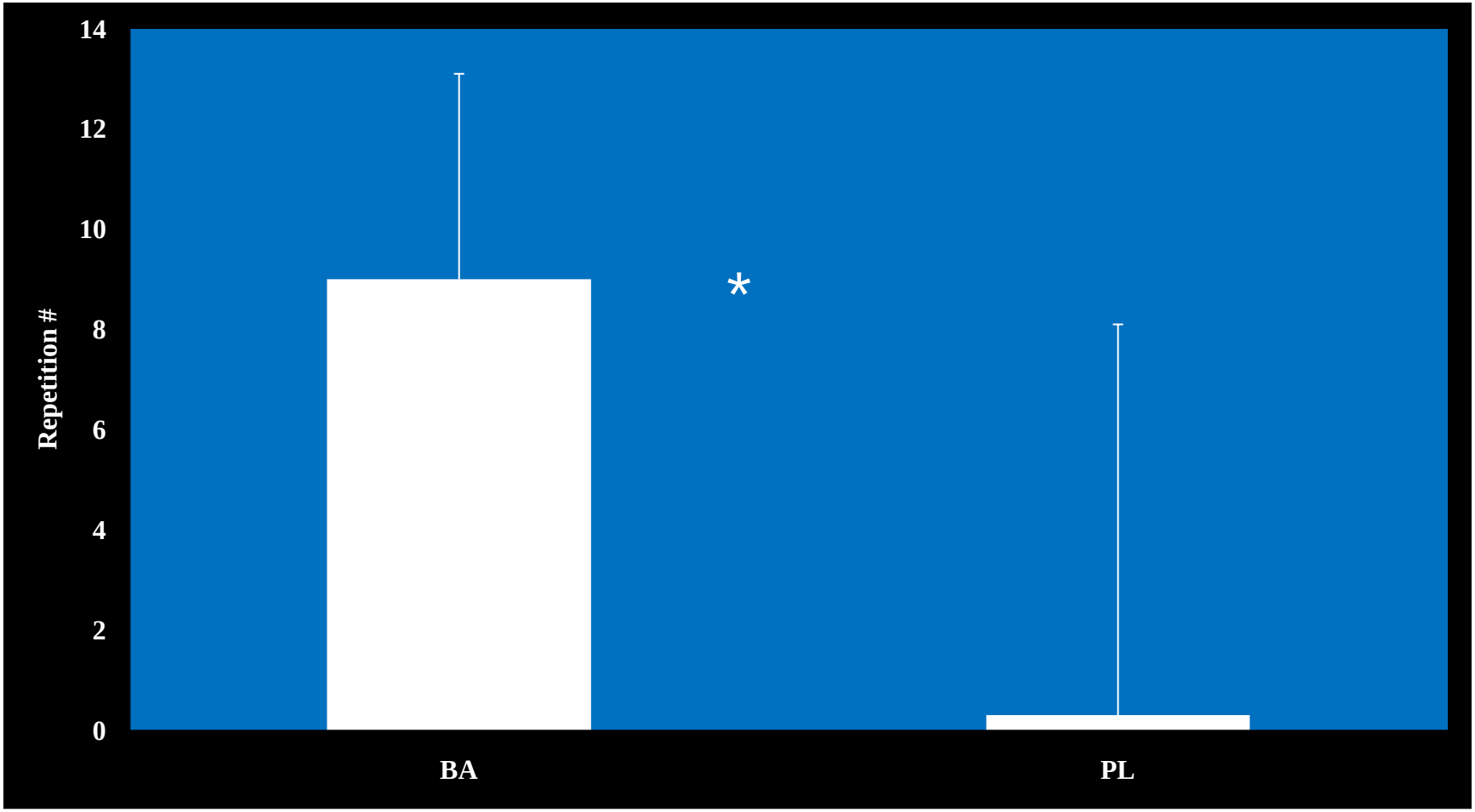


60 – sec Wingate Anaerobic Power Test – Fatigue Rate

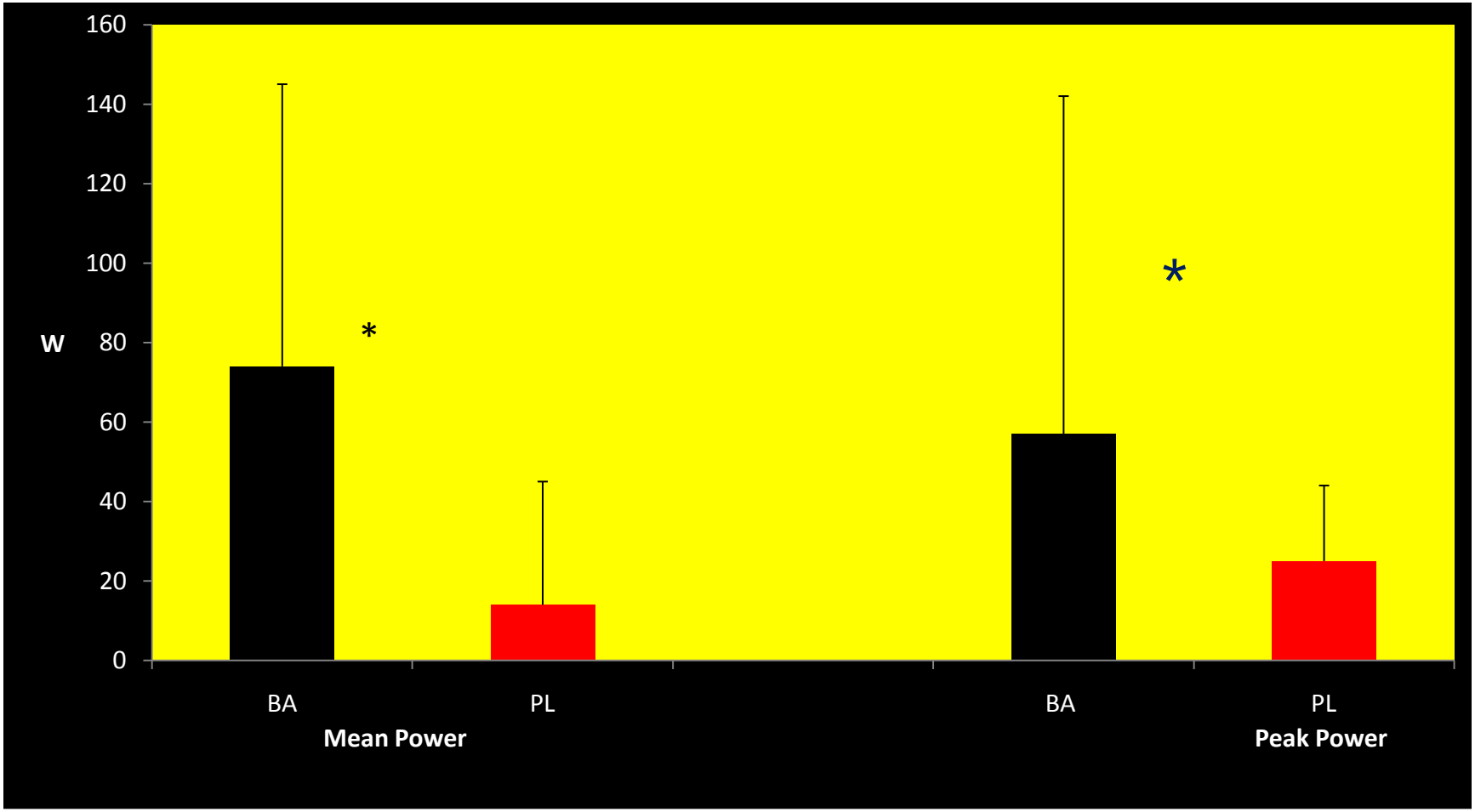
β-Alanine and the Hormonal Response to Resistance Exercise Hoffman et al., Int J Sports Med, In Press 2008)

- 30 days of β-alanine supplementation (4.8 g per day)
- 8 experienced resistance-trained men.
- An acute resistance exercise protocol
  - 6 sets of 12 repetitions (70% 1RM) of squat exercise (1-RM) with 1.5 minutes of rest.

Δ Repetitions



Δ Power



β-alanine Supplementation: Implication for Strength/Power Athlete

- Enhance buffering capacity
  - Play with higher lactic acid concentrations within muscle
  - Delay fatigue
  - Higher quality performance – greater intensity for longer periods of time.
  - Subjective feelings of recovery enhanced
- Results in an enhanced quality of the workout.

Conclusion

- Use of dietary and nutritional supplements may have an important role in maximizing athletic performance.
- Care must be taken to ensure that supplements used are both legal and efficacious.
- Quality of supplement may differ between manufacturers.
- Importance of insuring that the athlete has access to latest information to keep up with an always changing industry.

NEW AND INTERESTING SUPPLEMENTS

Choline

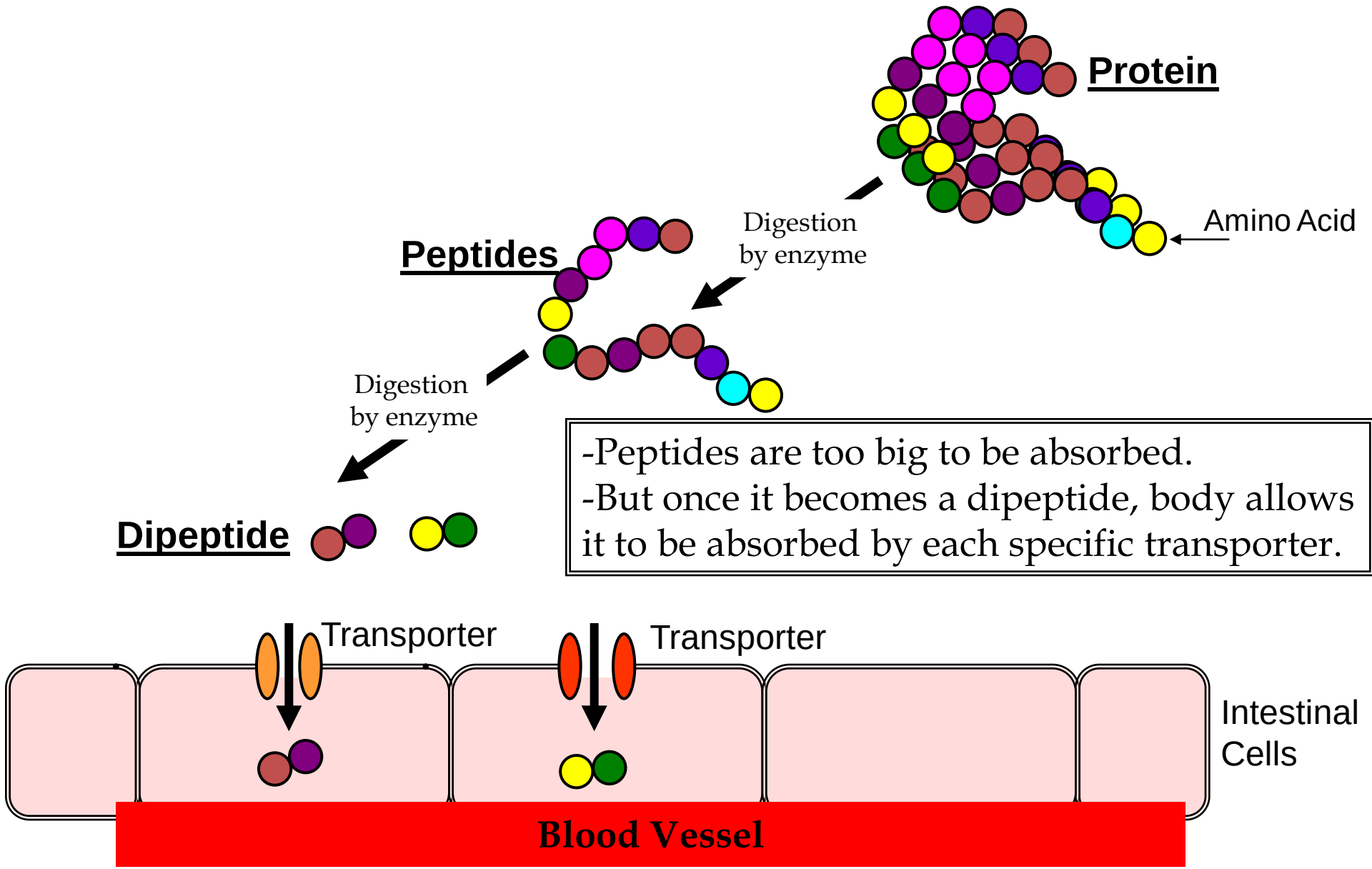
- Choline is an essential nutrient that has an important function in synthesis of the neurotransmitter acetylcholine.
- Acetylcholine is critical for many physiological functions, and any deficiency could result in a multitude of physiological problems.
- One of the more interesting findings has been the benefit that choline supplementation has had on memory and cognition improvements.
- May have a potential ergogenic role in prolonged operations by maintaining reaction time and power, even during operations with plasma choline concentrations are normal.

Use of Dipeptides

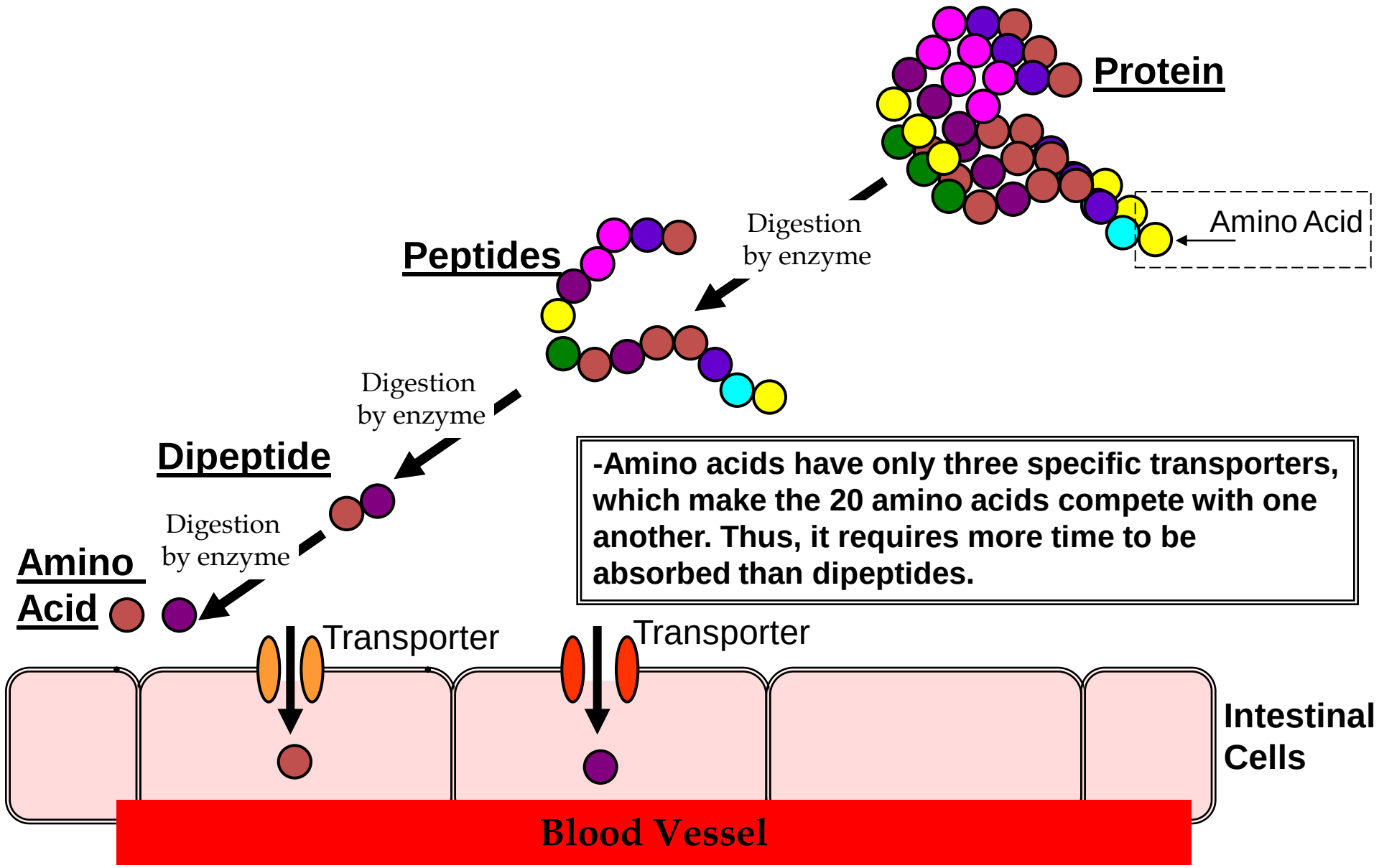
Absorption

- A dipeptide is the most efficient form of protein for absorption.
- Specific transporters exist on the gut surface, and accelerates absorption.
- In contrast, more energy is required to have the dipeptides to be broken down into amino acids, and only three types of transporters exist on gut membrane causing much competition between individual amino acids for uptake.

Absorption of Dipeptides and Peptides



Absorption of Dipeptide, Peptides and Amino Acids

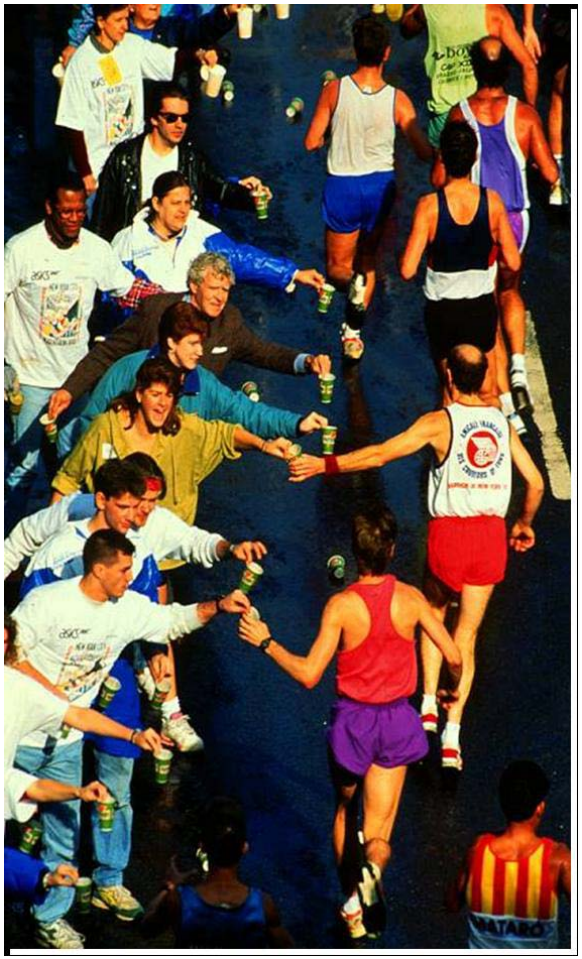


Alanine-Glutamine Dipeptide

- Clinical use
- Potential use in athletic and tactical performance
- Presently NOT on the market as a supplement.
- Interesting potential as part of a fluid replacement drink.

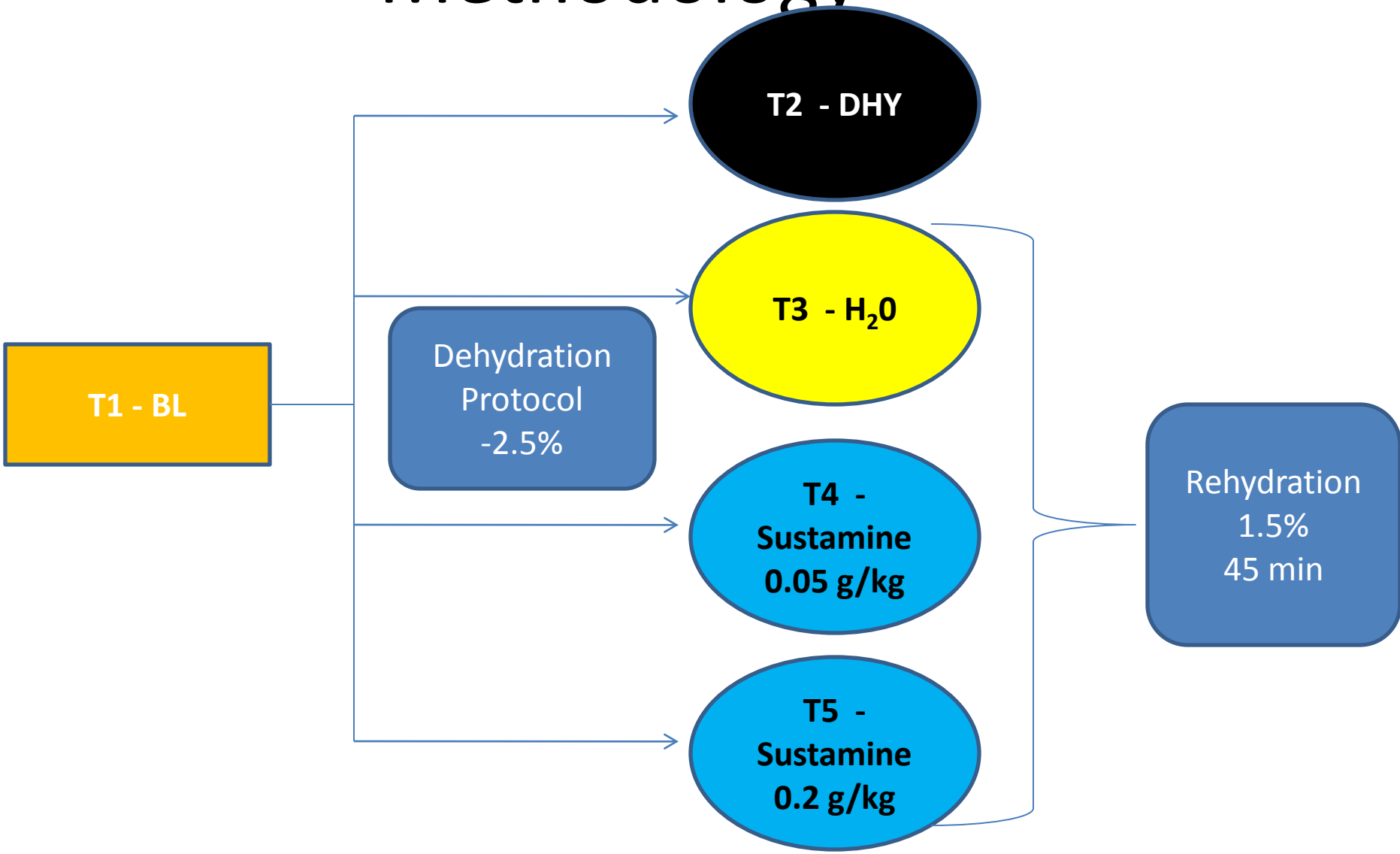
Implication for Exercise

- Enhance fluid regulation during prolonged exercise in the heat.
- Maintain or enhance performance during a hydration/heat stress.
- Enhance recovery from exercise by modulating immune, inflammatory and oxidative stress responses to physical activity.

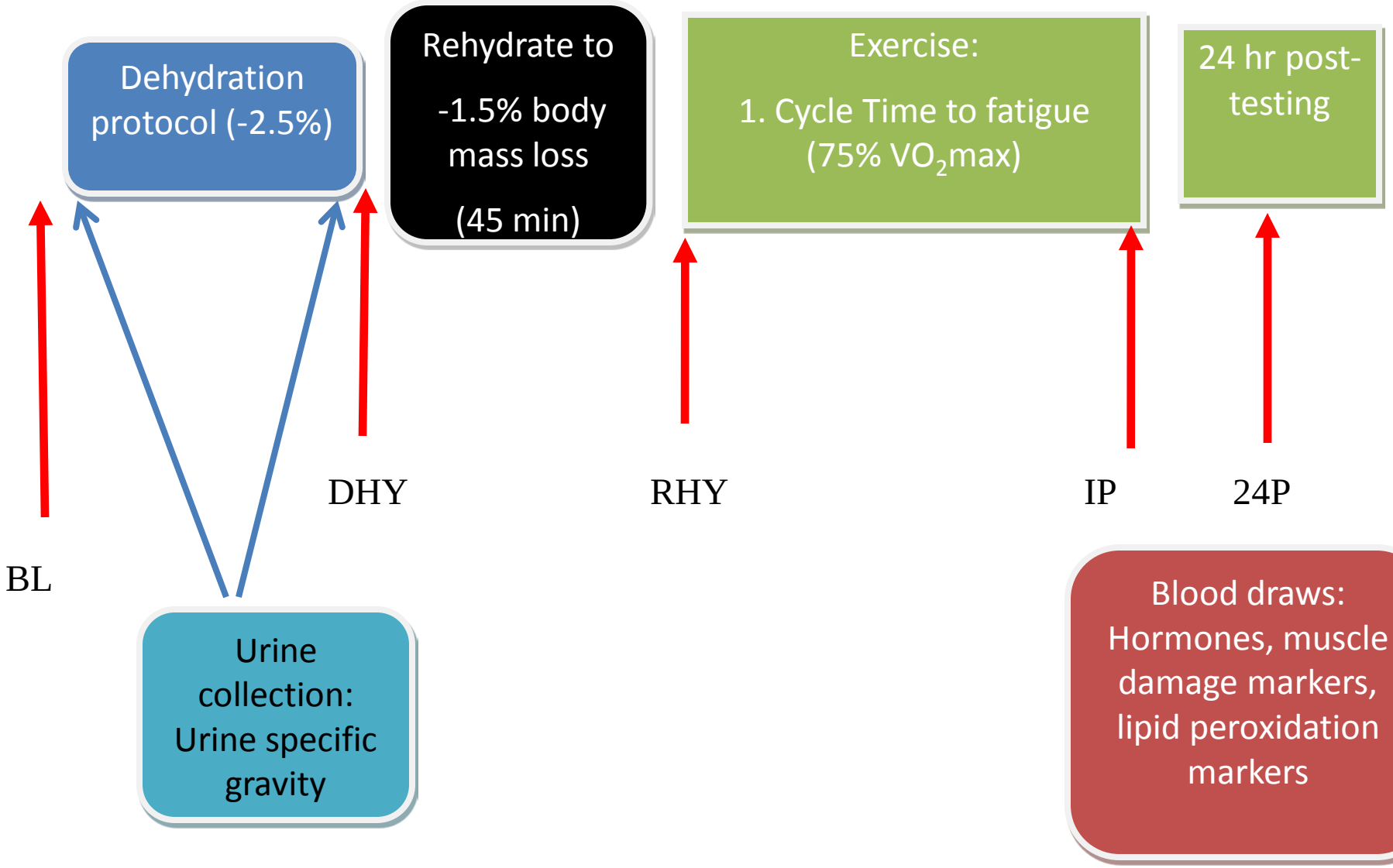


Hoffman et al., 2009

Methodology



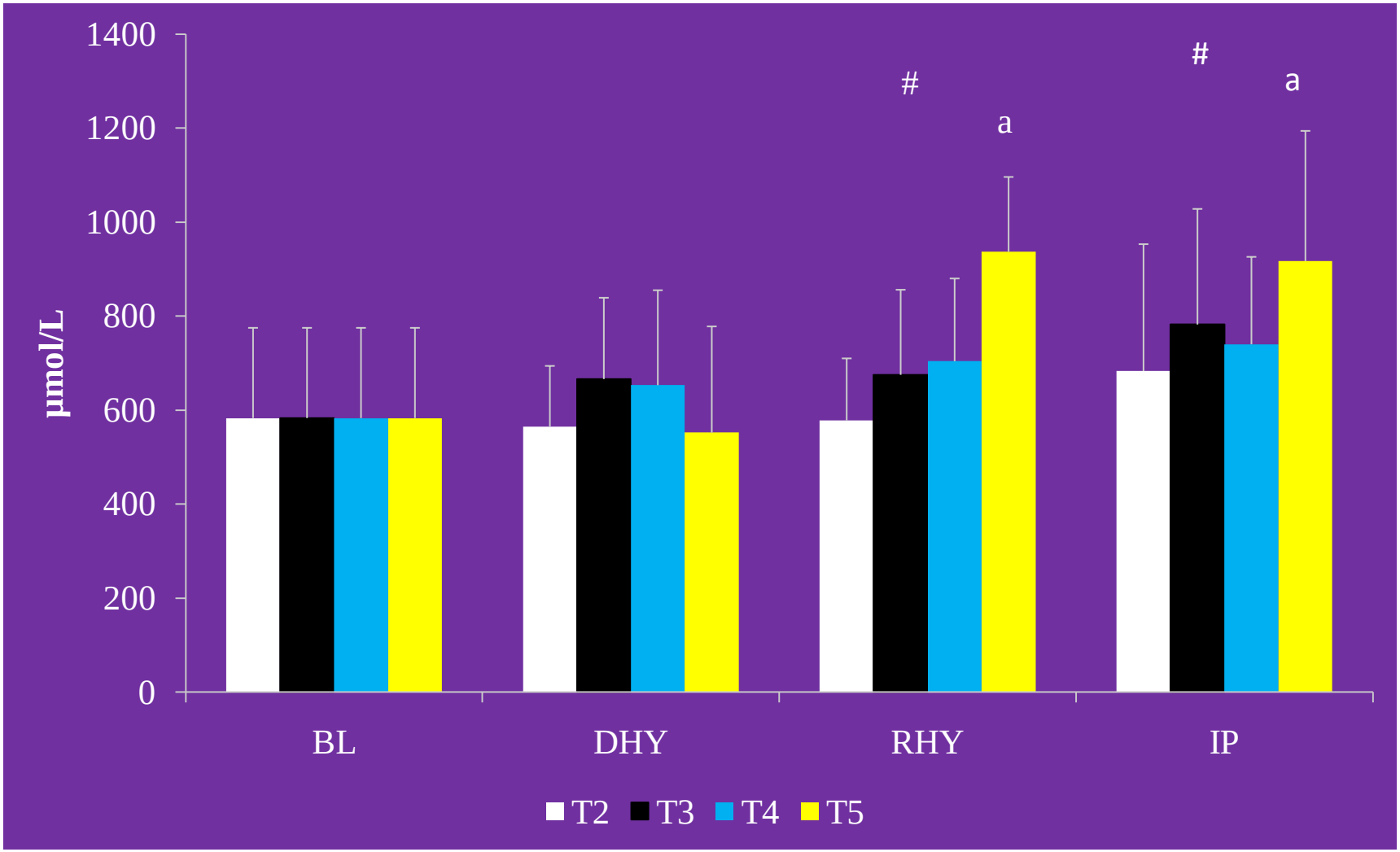
Study Protocol



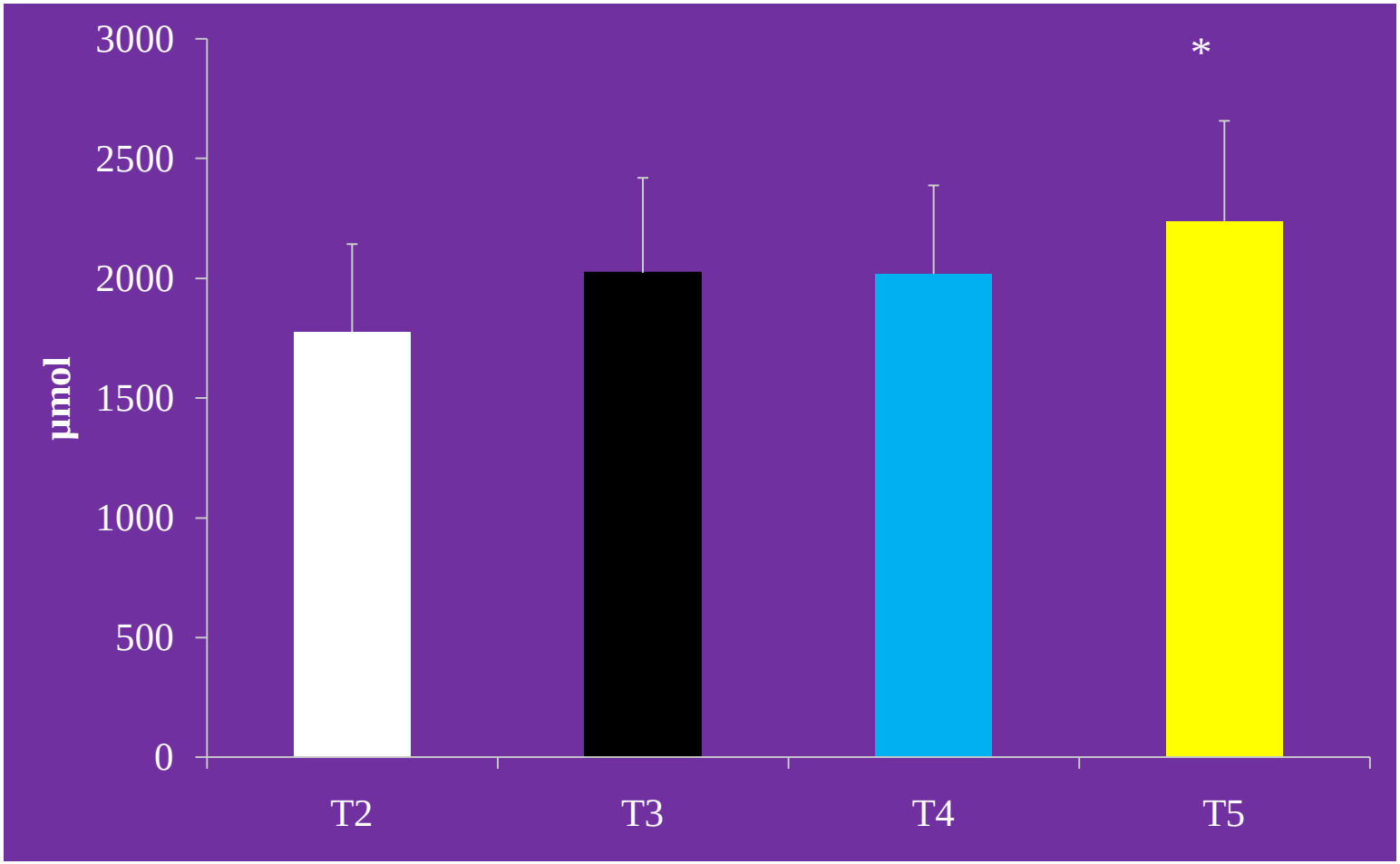
Dehydration Protocol

- Subjects achieved desired body weight (-2.5% body mass loss) through *passive* and *active* dehydration protocols.
- 62.5 ± 44.2 min

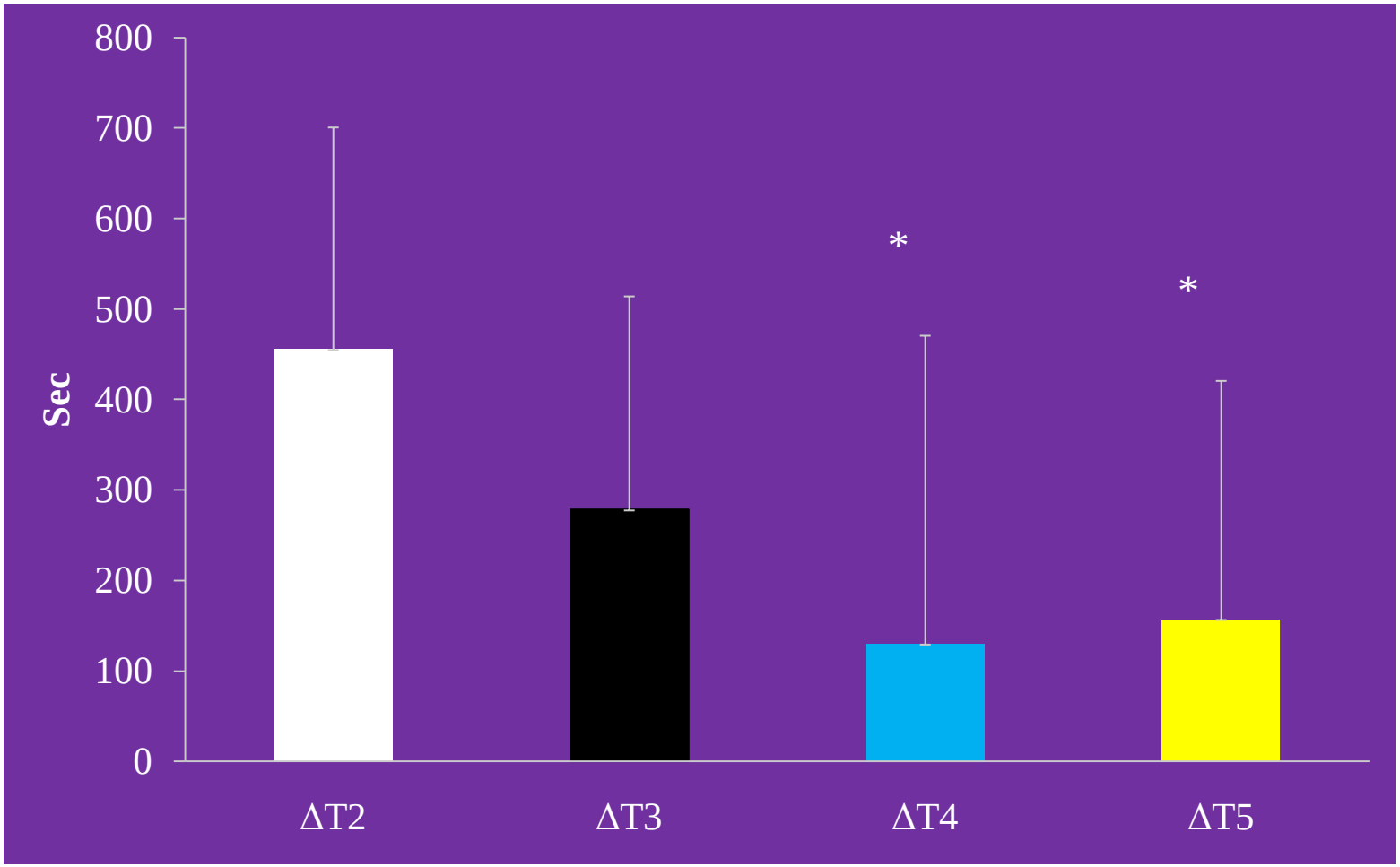
Plasma Glutamine Concentrations



Area Under the Curve: Plasma Glutamine



Δ Time to Exhaustion.



Thank you!