

# Effect of carnitine supplementation on endurance performance

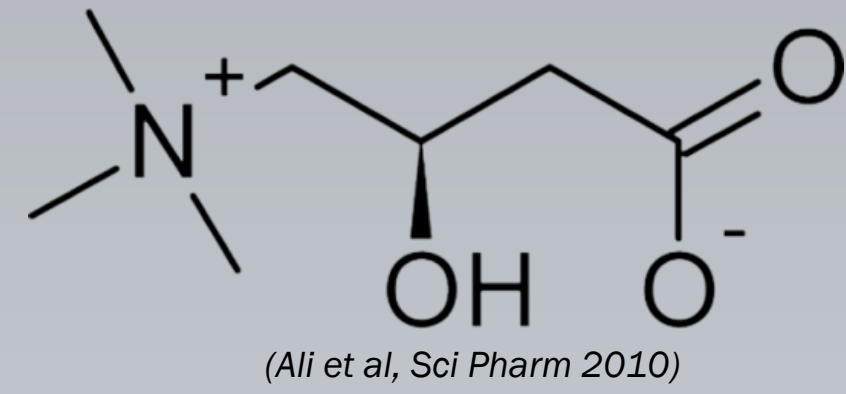
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KINE 4120: Nutritional Aids in Sport

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(Ali et al, Sci Pharm 2010)

## Abstract

Medical studies in the 1970's established L-carnitine's safety in clinical populations, and indicated good efficacy, especially in populations with certain metabolic diseases. Due to these promising findings, a growing volume of research on the effects of supplementation in athletes began shortly after. L-carnitine's best understood function is its ability to serve as a shuttle to get cytosolic acyl-chains into the mitochondria. However, it also has several indirect roles such as acting as an "acyl sink" or removing toxins from the body. Thus supplementation may effect athletic performance in a number of ways. The state of scientific literature on L-carnitine's efficacy may be described as inconclusive. However, new research indicates the compound's efficacy is affected by many factors which were largely unaccounted for in older studies (diets, insulin levels, prolonged exposure, etc.). New findings have helped clarify that L-carnitine may be beneficial especially to endurance athletes. 1 gram of L-carnitine taken at least twice daily (up to 5 times) alongside a large snack or drink high in carbohydrates is the recommended protocol.

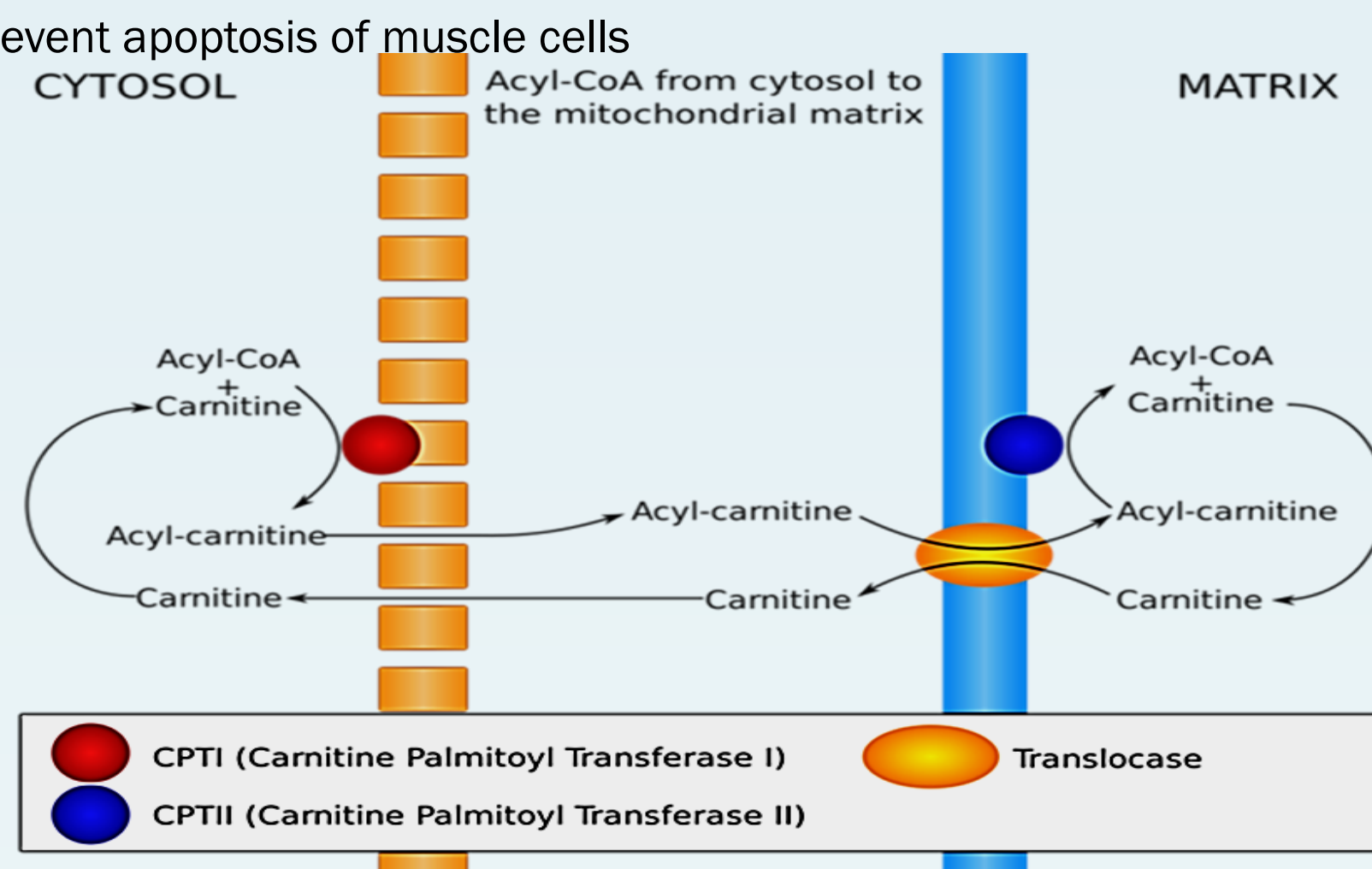
## Introduction

- First described in 1905, and clinical human research began in 1970's. These studies indicated that the compound was safe and was involved in the breakdown of fats
- The compound is both biosynthesized and attained from dietary sources (red meats)
  - Athletes may unknowingly be reaching supplemental levels from their diets

- Biosynthesis is affected by diet
- Absorption is saturable
- Gut-flora affects absorption
  - Oral vs IV, Diet
- Half-life into muscles: 2.3 hours
- Half-life out of muscles: 5.7 days
- Renal reabsorption is saturable

## Functions

- Acyl-Shuttle and Acyl-Sink
- May prevent apoptosis of muscle cells



Public Domain Image. Author: Slagt. Source: [https://commons.wikimedia.org/wiki/File:Acyl-CoA\\_from\\_cytosol\\_to\\_the\\_mitochondrial\\_matrix.gif](https://commons.wikimedia.org/wiki/File:Acyl-CoA_from_cytosol_to_the_mitochondrial_matrix.gif)

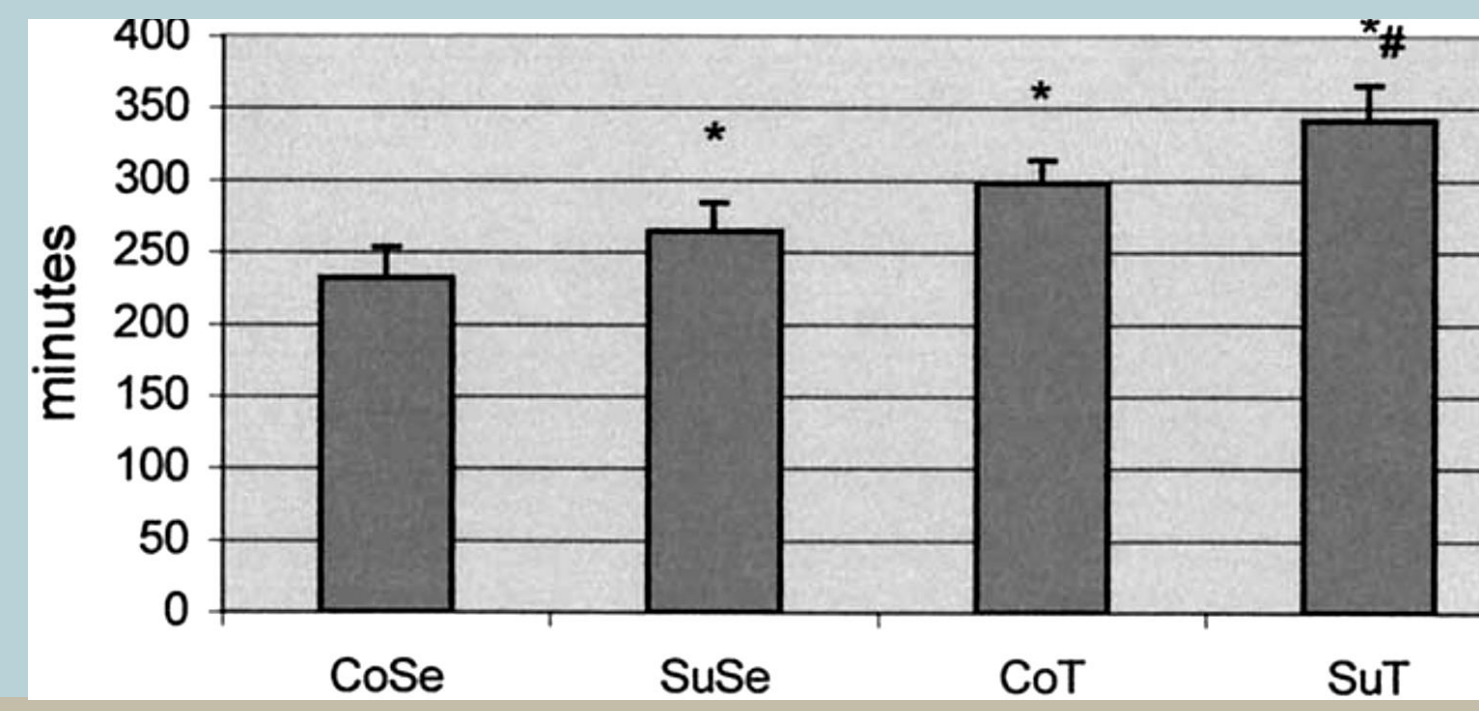
## Objectives

- To find out if supplementation is advantageous to endurance athletes
- Investigate possibility of a dose response and effects of treatment period

## Key Studies

### Bacurau et al, Nutrition 2003

- A rat study that investigated effects of supplementation and training on a time-until-exhaustion swim-test
- 6 week treatment period (gavage 28mg/kg bodyweight daily)
- Groups: 1) control, sedentary 2) supplemented, sedentary 3) control, training 4) supplemented, training
- n=20 per group



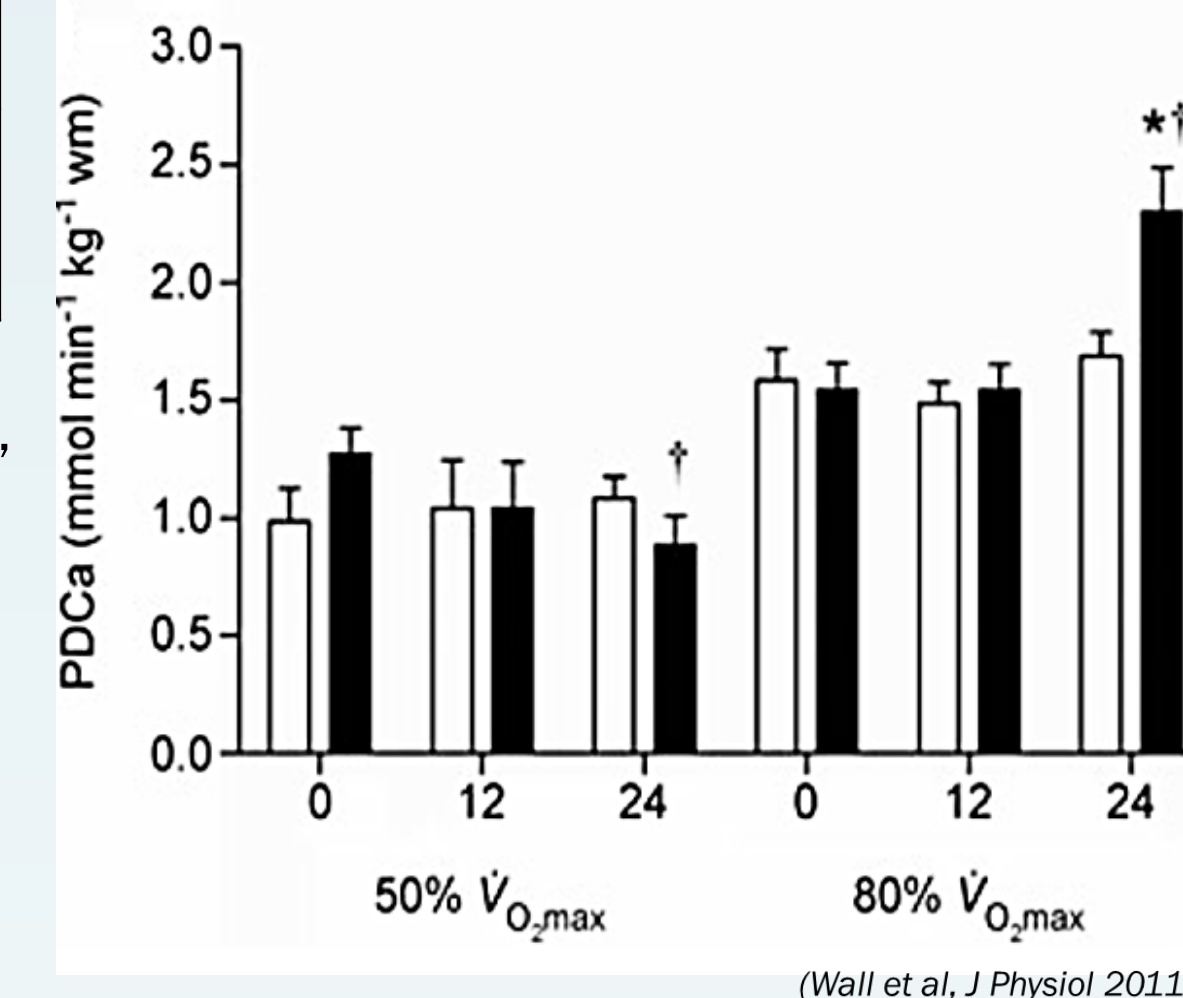
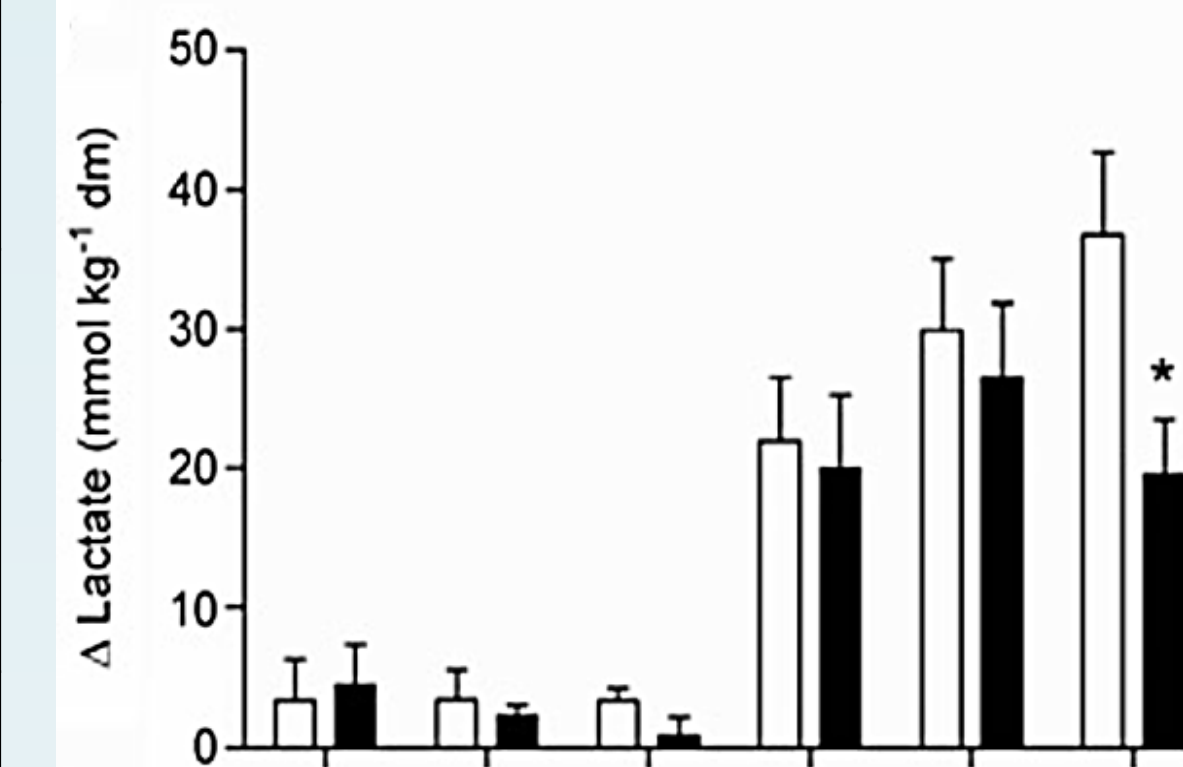
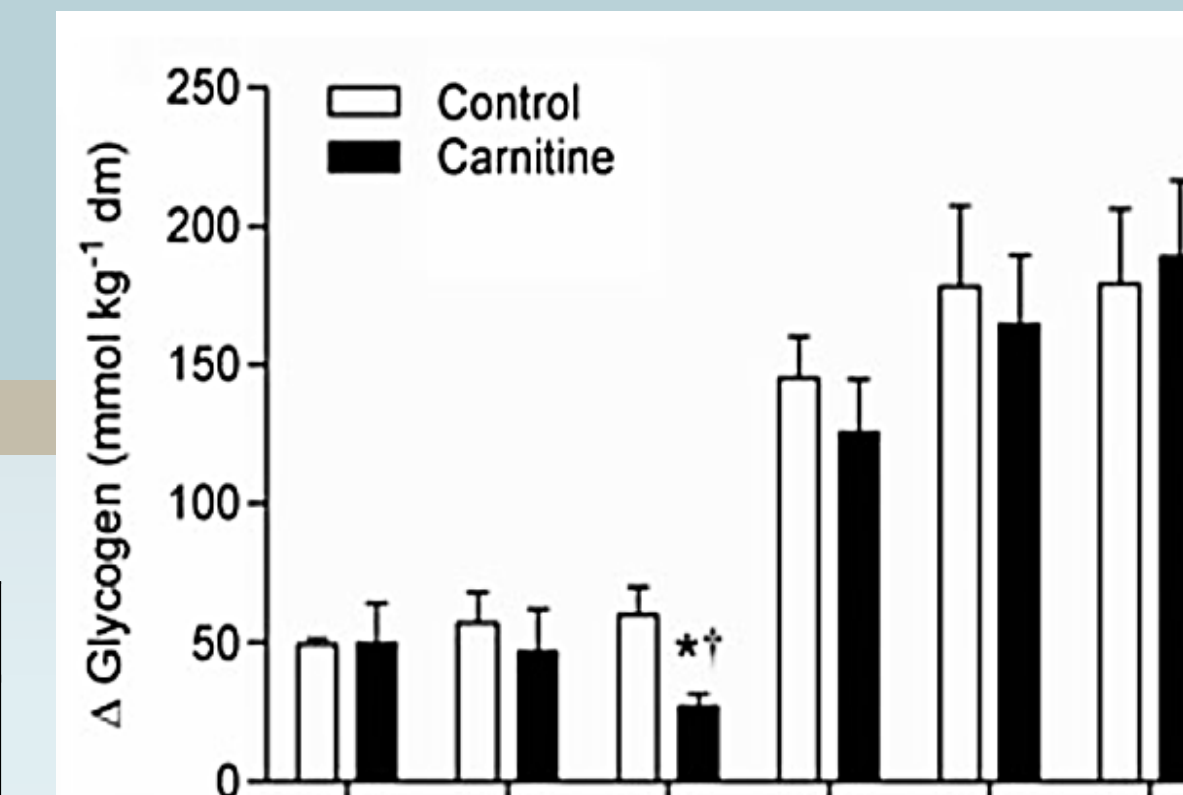
(Bacurau et al, Nutrition 2003)

### Wachter et al, Clinica Chimica Acta 2002 VS Wall et al, J Physiol 2011

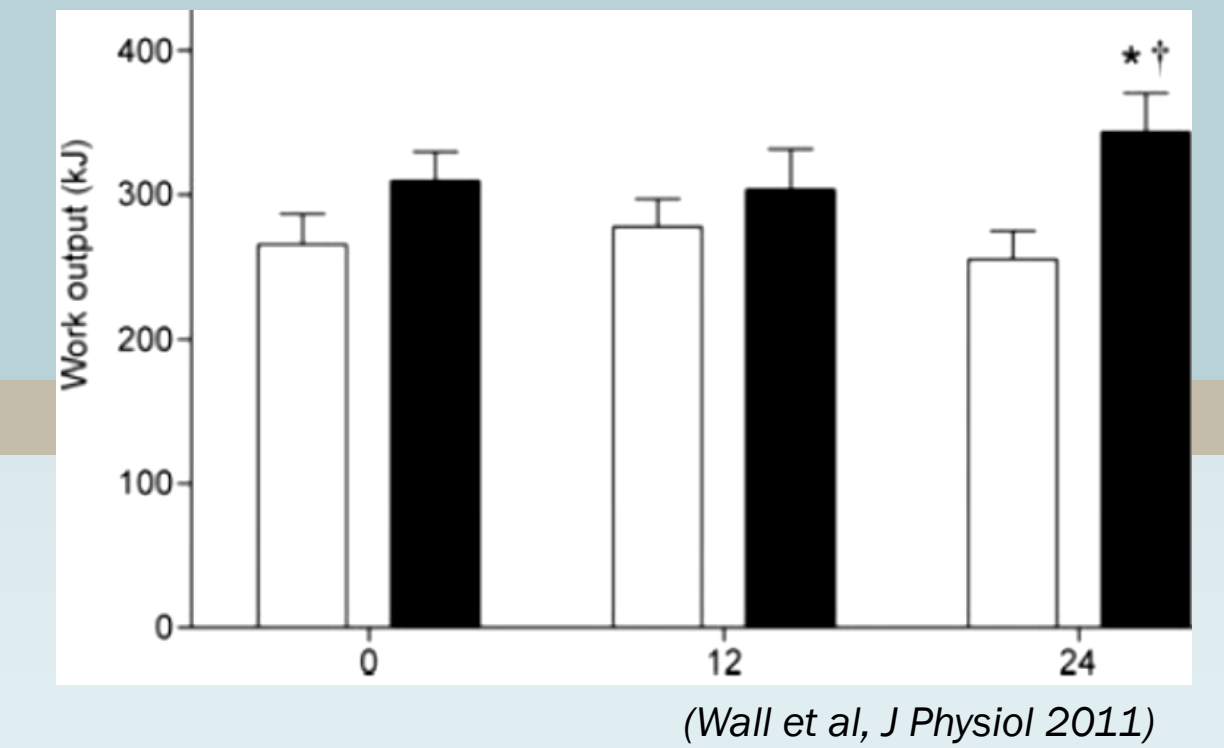
	Wachter et al	Wall et al	Similar?
N=	8, 7 finished tx period, 6 at post-tx follow up	14, so 7 per group	Yes
Subjects	Males, moderately trained, ages: 23-25	Males, moderately trained, ages: 24-28	Yes
VO2max pre-tx period	53.1 ± 4.1ml/kg	51.6 ± 2.5ml/kg	Yes
Control group	No real control group - Initial test served as control	Double blind, received 80g CHO drink only (BID)	No
Treatment Period, amount	3 months, 2g BID	6 months (test every 3 months), 1.36g WITH 80g CHO drink BID	Yes
Tests	20%, 40%, 60% (10 min each) of Pmax, then until failure using 30W/2 min increments	50%, 80% VO2max, work output performance trail (30 min each)	Yes
Other measurements taken	Muscle biopsy, blood, used NMR	Muscle biopsy, Borg RPE, blood	Yes

- Wall et al showed many significant findings in support of supplementation, Wachter et al did not.
- The two studies were very alike but had a few important differences
  - Time period of treatment
  - Supplementing with a CHO drink to boost insulin
  - Presence of a control group
- Both studies may suffer from type 2 error
  - $n = \frac{[(Z\alpha - Z\beta) \times SD]^2}{(\text{mean1} - \text{mean2})^2}$ 
    - where  $Z\alpha=1.96$  and  $Z\beta=-0.85$
- Wall et al found that supplementation may prevent weight gain

	Comparison of Findings		
	Wachter et al 3 months	Wall et al 3 months	Wall et al 6 months
Muscle Total Carnitine conc.	17% increase but not statistically significant	9% NS increase from baseline 17% NS more than control	22% SS increase from baseline. 31% SS more than control
Plasma Carnitine conc.	~ Doubled SS	Control: decreased NS 12% . Supplemented: increase NS 18%, SS had 37% more than control	Supplemented 32% SS more than control, and NS 23% increase from baseline.
Muscle Free Carnitine conc.	Remained unchanged	Control NS decrease of 9%, supplement group increase NS of 8% and NS 20% more than its control.	Same trends seen at 3 month continue.

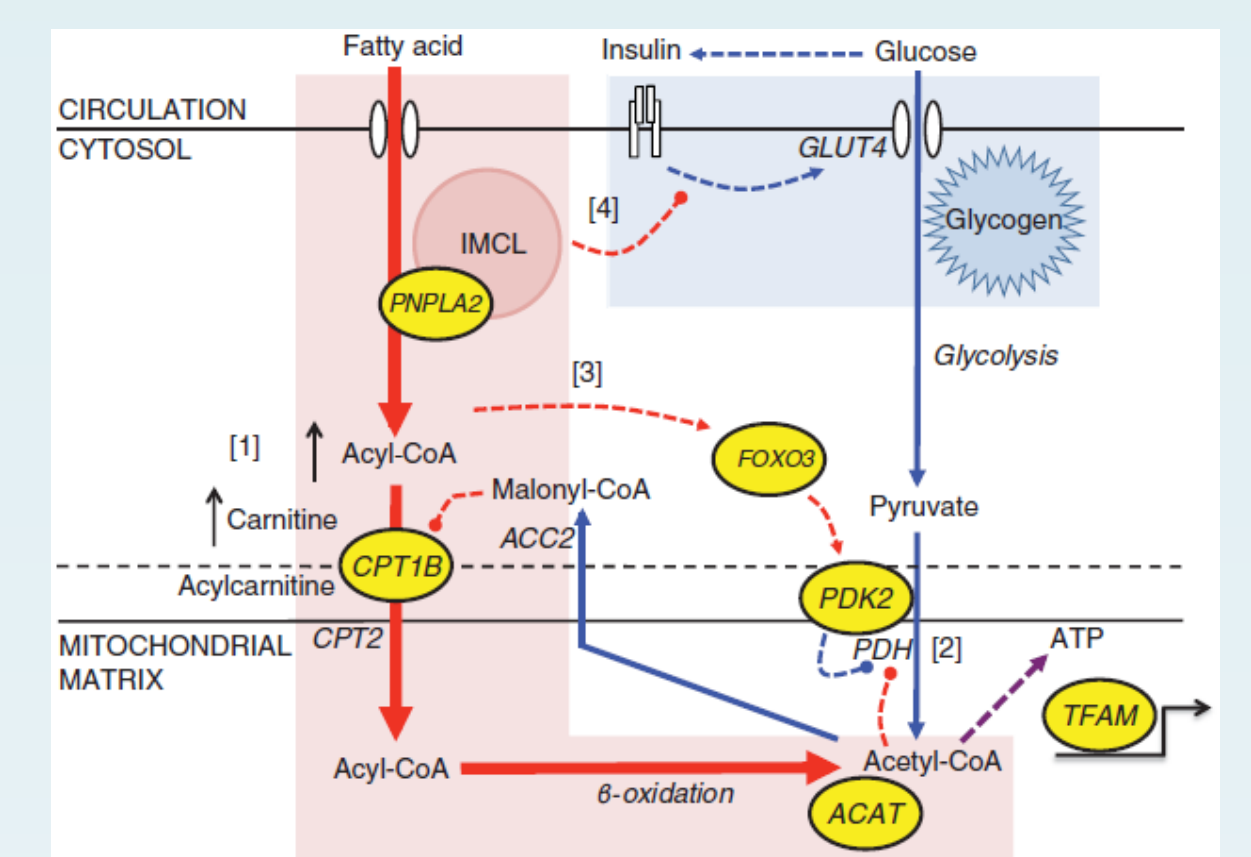


(Wall et al, J Physiol 2011)



(Wall et al, J Physiol 2011)

### Stephens et al, J Physiol, 2013



(Stephens et al, J Physiol, 2013)

## Conclusion

L-carnitine exerts its effects in a number of ways. 1) Genetic up-regulation of genes key to several metabolic pathways. 2) Decreasing dependence on glycogen at lower workloads 3) Increasing the rate glycogen can be used at higher workloads by stimulating PDCa. 4) Powerful antioxidant. The compound also has its key roles listed in the introduction. Taking 1 to 2g, two to four times daily with a CHO drink to induce an insulin spike is recommended for endurance athletes. Supplementation should be done for at least 6 months.