MISSION:
Scientific Discovery Leading to Improved Health and Performance

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Nutrition & lifestyle countermeasures to:

1. exercise- (ACUTE)
2. obesity- (CHRONIC)

induced:

- immune dysfunction
- inflammation
- oxidative stress
• 100 scientific papers (1/month)
• Novel scientific discoveries (PR)
  • Moderate exercise reduces cold incidence
  • 45-min vigorous exercise increases metabolism 14 h
  • Banana fruit ingestion by athletes dampens inflammation and COX-2 mRNA
• 75 graduate students, interns, and international scholars

AppState Research, 2009-2018, $5.04 million Industry External Funding

$3.03 million direct research costs

$1.2 million back to AppState

$856,800 to the community (stipends)
Scientific Discovery Philosophy

✓ Double-blinded, placebo controlled research designs.
✓ Collaboration.
✓ Use of advanced technologies (metabolomics, genomics, proteomics, biopsies, ultrasound, metabolic chamber)
Physiological Stress from Prolonged and Intensive Exercise

**Innate Immune System:**
Dysfunction, activation of NK cells, neutrophils, macrophages

**Stress Biomarkers:**
Elevated stress hormones, oxidative stress, tissue damage, inflammation

**Metabolomics:**
Extensive and sustained shifts in lipid and Kreb Cycle metabolites

**Proteomics:**
Large-fold increases in proteins related to inflammation and phagocyte migration

**Lipidomics:**
Large-fold increases in PUFA-lipid mediators

**Physiological Stress from Prolonged and Intensive Exercise**
Relationship Between Exercise Workload and Immune Response, and Immunonutrition Support

**Marathon-type Exercise**

- Physiologic stress
- Immune stimulation
- Immune dysfunction
- Oxidative stress
- Inflammation

**Moderate Exercise**

- Open Window

**Time (h)**

0 1 2 3 4 5 6 7 8 9 10
Carbohydrate ingestion:

- ↓ inflammation (reduced neutrophilia, monocytosis, plasma IL-6, IL-1ra, IL-10, MCP-1; muscle IL-6, IL-8 mRNA)
- ↑ performance (2-6%)
- ↑ serum glucose, fructose, insulin
- ↓ cortisol, epinephrine

Fruit polyphenols - oxidative capacity

METABOLOMICS
Fat oxidation and metabolite shifts ↓50%

OPLS-DA score scatter plot, 20 cyclists, pre-post ratios, 75 km cycling

Sugar
Bananas
Water

Nutrients 2017, 9, 513; doi:10.3390/nu9050513
J Proteome Res 2015 Dec 4;14(12):5367-77
OPLS-DA score scatter plot, 20 cyclists, pre-post ratios, 75 km cycling
Global Metabolomics

- ferulic acid 4-sulfate
- vanillic alcohol sulfate
- 2,3-dihydroxyisovalerate
- dopamine 4-sulfate
- dopamine 3-O-sulfate
- 3-methoxytyramine sulfate
- 2-oxoarginine
- 4-imidazoleacetate
- 5-hydroxyindoleacetaetate (serotonin)
- tyramine O-sulfate
- eugenol sulfate
- 2-isopropylmalate
- caffeic acid sulfate
- trigonelline (N'-methyl nicotinate)
- S-methyl methionine
Reduction in COX-2 mRNA expression with banana intake, post 75-km cycling

COX-2 mRNA fold ratio relative to GAPDH

Water
Sugar water
Cavendish
Sports banana


Treatment in human monocytes, THP1 for 6h
Banana carbohydrates support performance, decreases inflammation and moderates physiological stress.

Top 40 Foods for Polyphenols
(mg in a typical serving)

**Polyphenol Metabolism**

1. Dietary polyphenol intake (majority to colon)
2. Converted by colon bacteria to simple phenolics
3. Absorbed and translocated via portal vein to liver
4. Phase-2 conjugation
5. Released into circulation, exerts bioactive effects, and then eliminated in urine

**Hydroxybenzoic Acid**

**Hippuric Acid**

**Polyphenol (cyanidin)**

*Nutrients 2017, 9, 513; doi:10.3390/nu9050513*
Long-term, high diet polyphenol intake

↓ Mortality
↓ Hypertension
↓ Cardiovascular disease
↓ Diabetes
↓ Acute respiratory illness
↓ Oxidative stress
↓ Weight gain
↓ Inflammation
↓ Neurodegenerative diseases

Sources: Nieman DC. Nutrients. 2017 May 18;9(5); Nutrients 2016, 8, 636.
Increased polyphenol intake

Counts exercise-induced immune dysfunction

Higher levels of phase II and gut-derived phenolics

Improved immune cell function and pathogen defense

Plasma Hippurate (MSI)

Pre-Suppl 2-Wk Suppl Post-Exerc 14h Post-Exerc

Flavonoid Placebo

Serum Viral Replication (arbitrary units)

Pre-Suppl 2-Wk Suppl Post-Exerc 14h Post-Exerc

Flavonoid Placebo
A 45-Minute Vigorous Exercise Bout Increases Metabolic Rate for 14 Hours.
45 min vigorous, sweat producing, exercise: 519±61 kcal

14.2 h post-exercise, 190±71 kcal, net energy expenditure
ASU-North Carolina Research Campus
Human Performance Lab