About your Speaker

Ph.D. in Human Nutrition, University of Minnesota

Registered Dietitian Nutritionist (RDN), Commission of Dietetic Registration (CDR)

Certified Board Specialist in Sports Dietetics (CSSD)

Research focus-Intersection of sports nutrition and gut health, prebiotics

Mom of two-Ava 5.5 yrs., Hannah 3 yrs.

Fun facts: World traveler, fitness-focused, I was a former cheerleader

Disclosures

- Owner, Dr. Renee Korczak Nutrition, Bernardsville, NJ
- Teaching & Research appointment, Department of Food Science and Nutrition, University of Minnesota
- Per Diem Sports Dietitian, Saint Barnabas Healthcare System, NJ
- Scientific and Medical Affairs Consultant Dietitian, OLIPOP

Objectives

- Introduce the gut as an athletic organ and
- To understand gender differences in the athletic microbiome and adaptations that may occur with training
- To describe advancements in prebiotic fiber research as it relates to gut health and performance nutrition

Is the Gut an Athletic Organ?
A 25 year + Scientific Discussion

Review > Sports Med. 1993 Apr;15(4):242-57. doi: 10.2165/00007256-199315040-00003.

Is the gut an athletic organ? Digestion, absorption and exercise

F Brouns [1], E Beckers

Affiliations + expand

PMID: 8460288 DOI: 10.2165/00007256-199315040-00003

Comment > J Appl Physiol (1985). 2011 Jan;110(1):278; discussion 294.
doi: 10.1152/japplphysiol.01259.2010.

Don't forget the gut--it is an important athletic organ!

Trent Stellingwerff, Asker E Jeukendrup

PMID: 21228188 DOI: 10.1152/japplphysiol.01259.2010

Free article

Research Article

More than a gut feeling: What is the role of the gastrointestinal tract in female athlete health?

Jamie N. Pugh, Katherine M. Lydon, Ciara M. O'Donovan, Orla O'Sullivan & Sharon M. Madigan

Pages 755-764 | Published online: 20 May 2021

Cite this article https://doi.org/10.1080/17461391.2021.1921853 Check for updates

Overall Benefits of Exercise & Performance on the Gut Microbiota

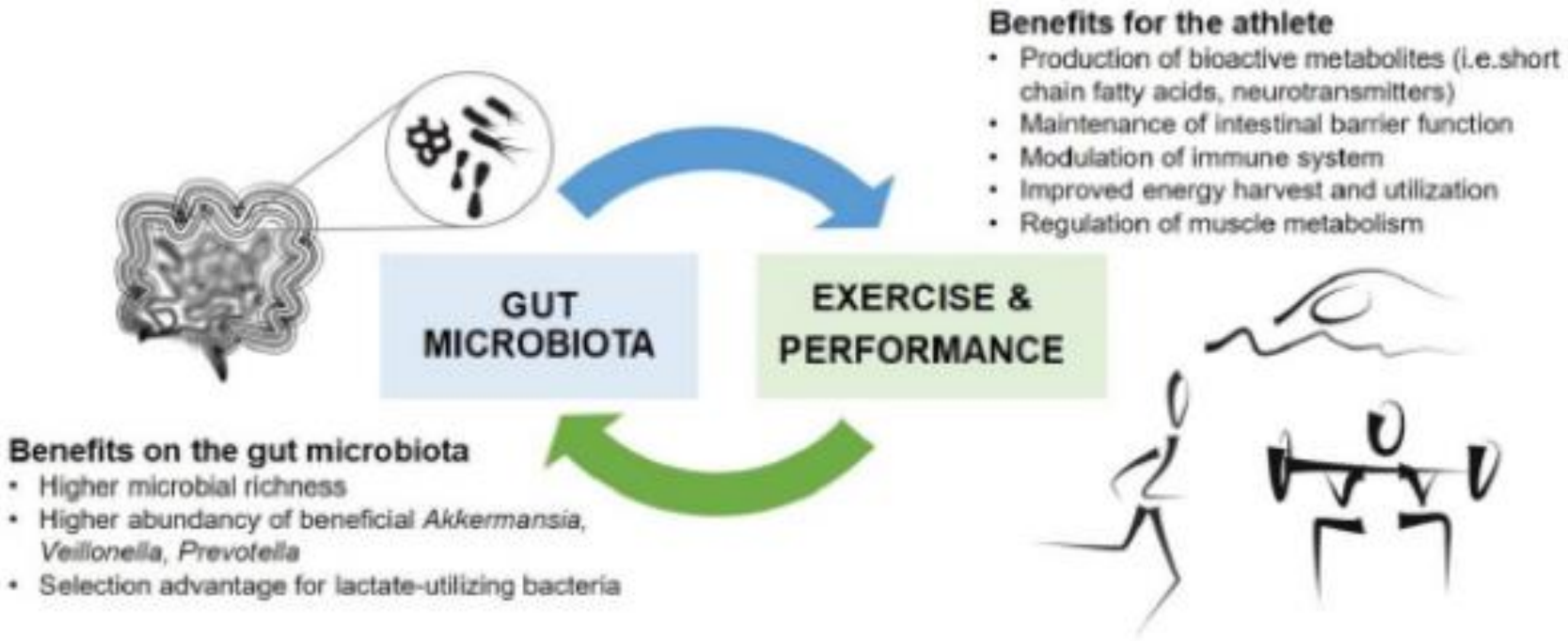

Figure from: Marttinen M, et al. *Nutrients* 2020; 12: 2936.

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Exercise and the Microbiome

Athletes who exercise regularly have a more diverse gut microbiome than those who are sedentary.

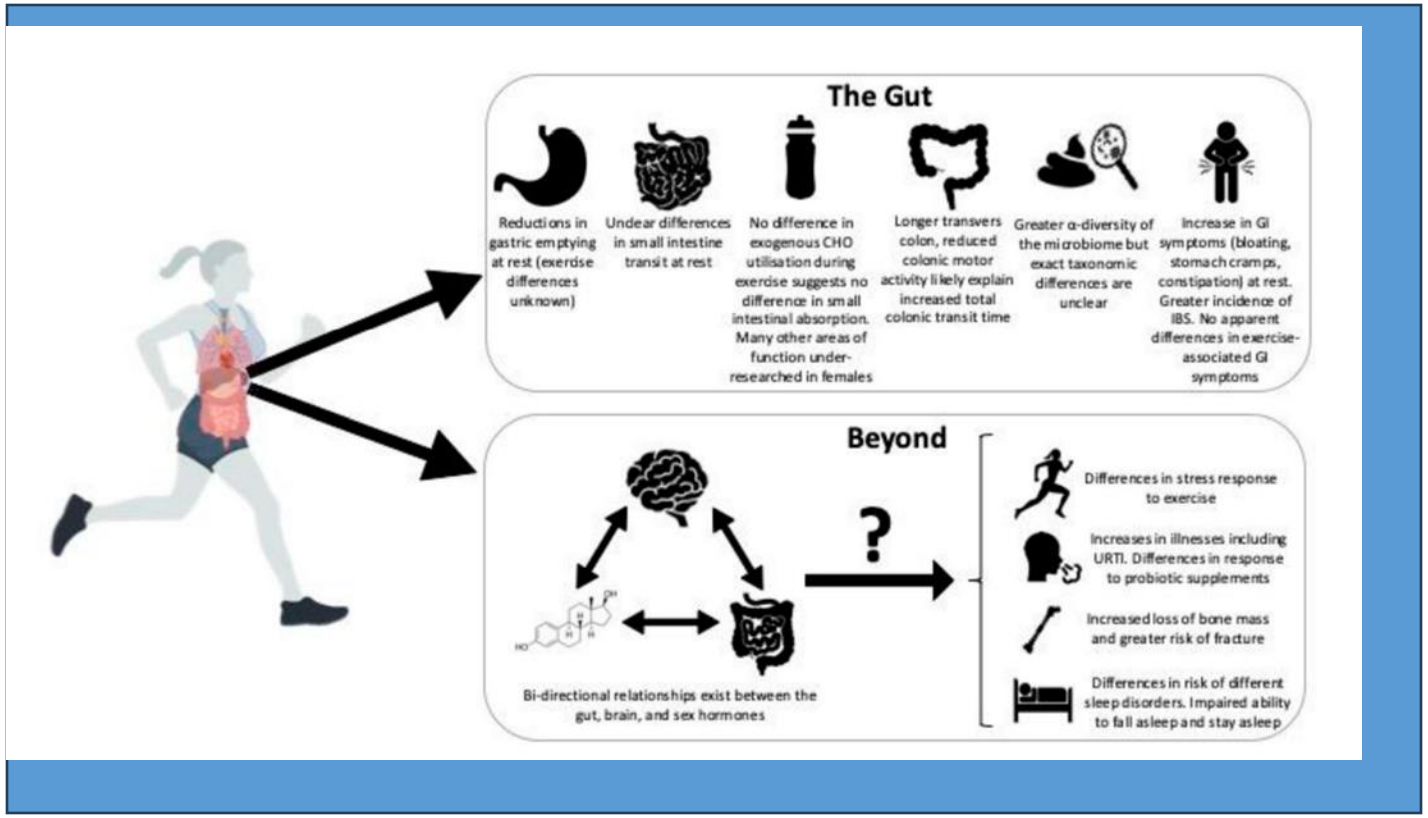
Several publications note athletes present with microbial populations that are enriched in health-promoting species and have greater diversity

Exercise increases α -diversity and increases commensal taxa such as:

- *Bifidobacterium*
- *Lactobacilli*
- *Akkermansia*

Pugh J, et al. Eur Jour Sports Sci 2022; 5:755-764.
Hughes R.L. *Adv Nutr.* 2021; 12(6): 2190-2215.

Gender Differences and the Gut



Female Athletes

- May have greater α -diversity of the microbiome, but exact taxonomic differences are unclear
- Hormonal influence (*ex: colonic transit is prolonged during the luteal phase of the menstrual cycle*)
- Increase in GI symptoms during menstruation and higher prevalence of IBS
- Bi-directional communication between gut, brain and sex hormones

Pugh JN, et al. *Eur J Sport Sci* 2022

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Editorial: Nutrition to support gut health and the microbiome in athletes

Imran Khan*

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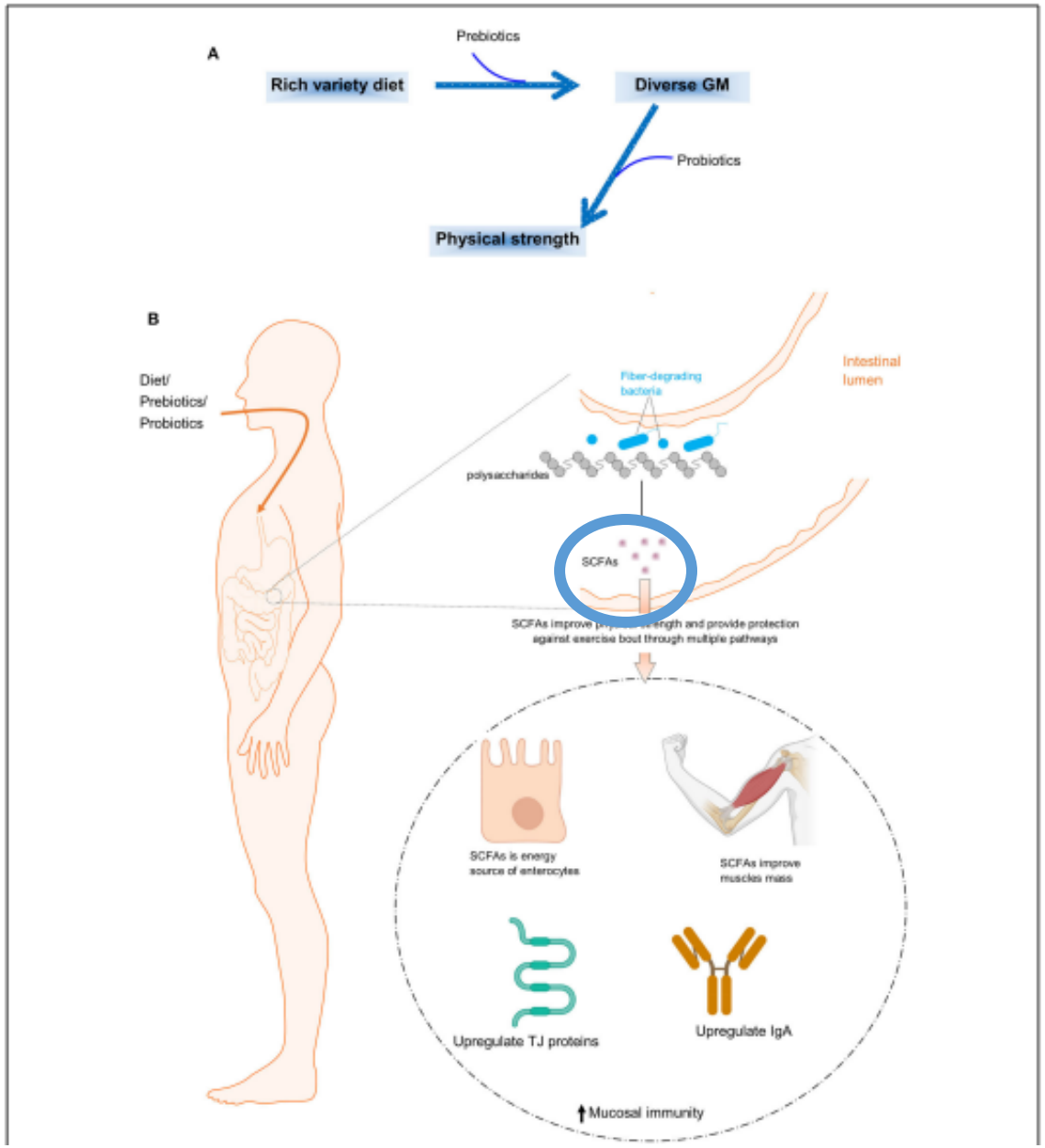
KEYWORDS

physical fitness, exercise, gut microbiota, bacteria, prebiotics, probiotics

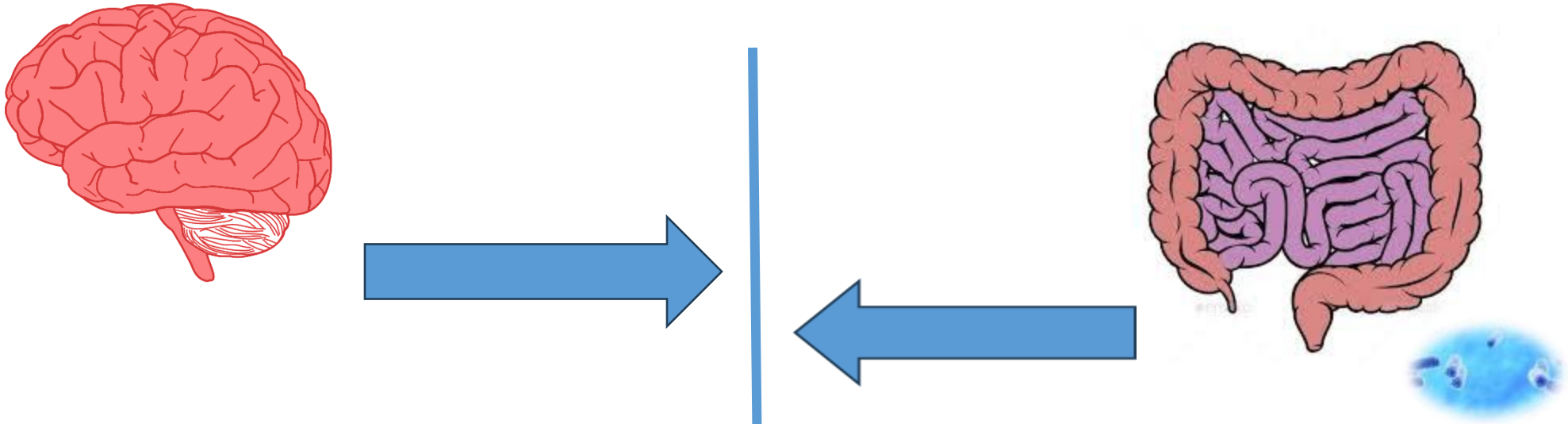
Khan I. *Frontiers in Nutrition* 2023



- Diet can influence gut microbiota diversity and composition and consequently improve physical exercise
- Prebiotics feed beneficial bacteria in the gut and yield SCFAs, which have multiple benefits for athletes
- GI health, **mental health (energy and cognition)**, immune health and bone health

Khan I. *Frontiers in Nutrition* 2023

The Gut & Brain Talk ALL the Time



20% is efferent

Messages are going from brain to body

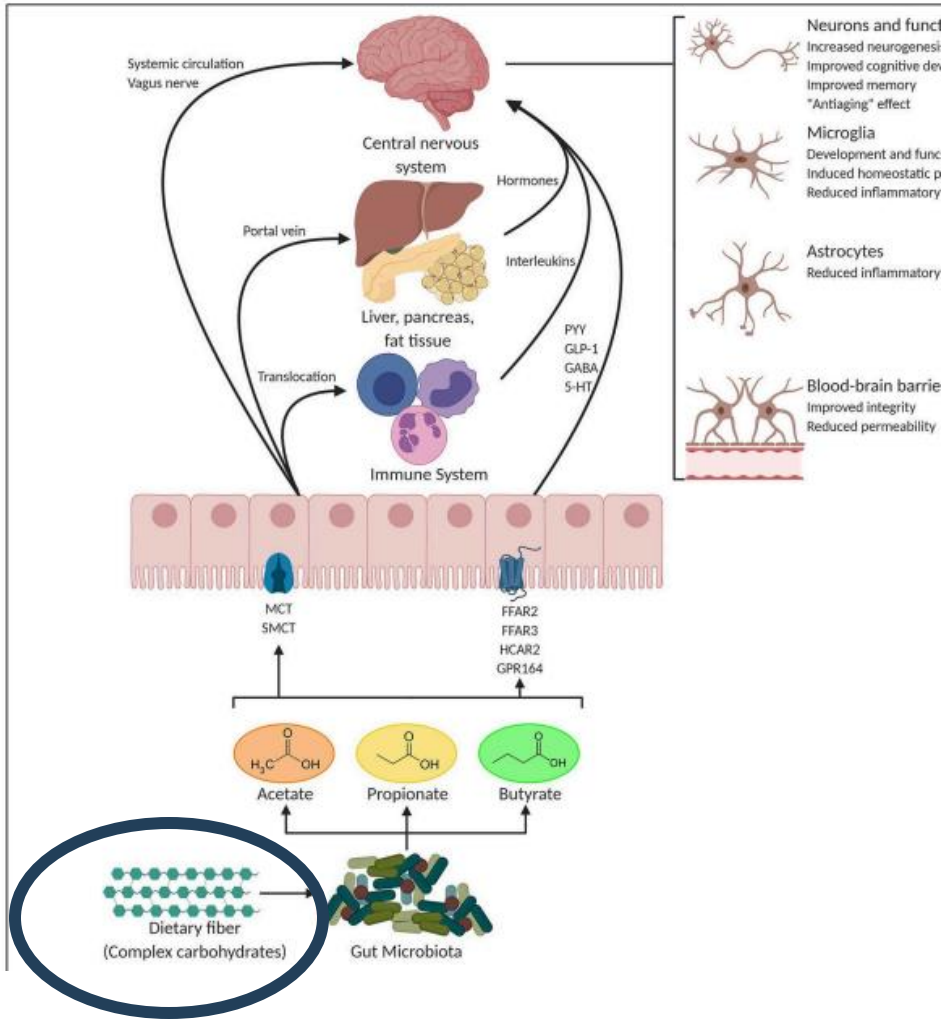
80% is afferent

Messages are going from body to brain

Bonaz et al. Front Neurosci 2018.

SCFAs and the Brain

- SCFAs may influence gut-brain communication and brain function directly or indirectly
- Following their production, SCFAs are absorbed by colonocytes
- Interaction with enteroendocrine cells promotes indirect signaling to the brain via systemic circulation or vagal pathways by inducing the secretion of gut hormones
- They can cross blood brain barrier
- Influence neuroinflammation
- Modulate the levels of neurotropic factors, increase neurogenesis, increase production of serotonin and improve neuronal homeostasis and function



Silva YP, Bernardi A, Frozza R. *Frontiers in Endocrinol* 2020

Prebiotic Intervention and Markers of Athletic Performance

Effects of 24 wk Prebiotic Intervention in Elite Rugby Players

Study Summary

- 33 male, elite rugby players, age 23.4 yrs.
- Investigate the effect of a daily prebiotic supplementation on URS, GI symptoms and immune function during regular rugby season
- Randomly assigned to consume a prebiotic

  (*2.9 g/day GOS*) or placebo (*2.8 g/day maltodextrin*)

  daily for 168 days under DB conditions
- Participants completed daily and weekly questionnaires for self-reported upper respiratory and GI symptoms
- Blood and saliva collected for assessment of plasma TNF, CRP and saliva IgA (0, 84, 168 days)

Topline Results

- GI symptom severity and incidence were lower in the prebiotic group vs. placebo

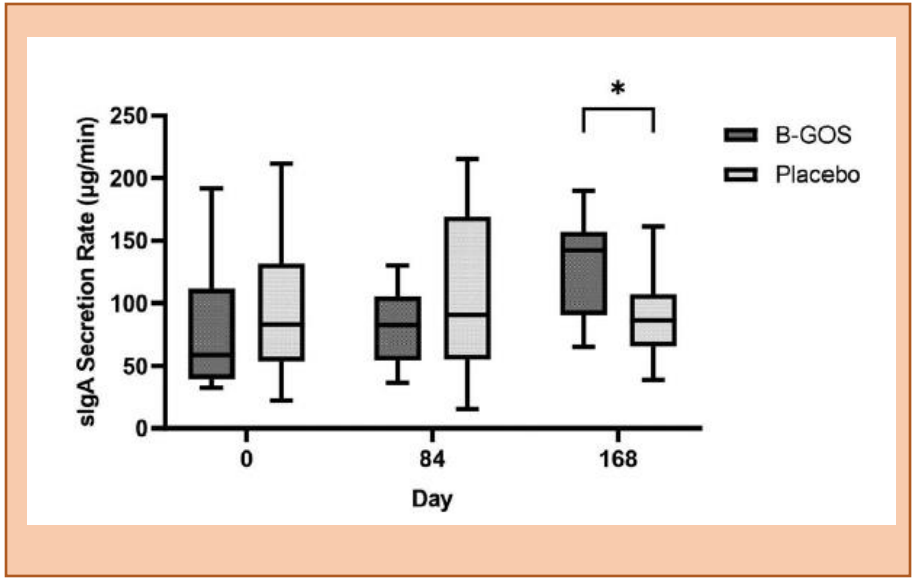
Symptoms	*B*-GOS Mean (SD)	Placebo Mean (SD)	Mean Difference 95% Conf. Interval	*P*-values *t*-test
Total GIS free weeks	11 (5.2)	7 (4.9)	4 (0.2; 7.5)	0.041
Upper GIS free weeks	15 (2.7)	11 (3.6)	4 (1.5; 6.1)	0.002
Lower GIS free weeks	11 (5.0)	9 (4.9)	3 (−1.0; 6.3)	0.151

Parker C, et al. *Euro Journal Sports Sci* 2023

Effects of 24 wk Prebiotic Intervention in Elite Rugby Players, *contd.*

Results on Self-reported URS data

- Prebiotic group experienced a 2-day reduction in URS duration
- Salivary IgA secretion rate was 42% greater in the prebiotic group vs. placebo group at day 168 (p=0.004); no differences in CRP and TNF-α



	B-GOS				Placebo				
	Mean	SD	Median	Range	Mean	SD	Median	Range	*P* Value
Episode Duration (days)	7.42	2.83	7.00	(4-15)	9.82	4.05	10.00	(4-17)	0.045
Incidence (episode per person)	1.00	1.44	1.00	(0-5)	1.00	1.00	1.00	(0-3)	0.641
Severity (symptom score per episode)	43.47	27.41	35.80	(14-118)	59.97	34.17	50.00	(15-138)	0.118

Parker C, et al. *Euro Journal Sports Sci* 2023

Acute Effects of Oligofructose-Enriched Inulin on Subjective Wellbeing, Mood and Cognitive Performance

Study Details

- Determine acute effects of oligofructose-enriched inulin (5g) over a 4 hr. period
- Inulin added to a breakfast cereal and toast w/tea and coffee
- DB, crossover study, maltodextrin control
- 28 F/19 M, mean age 23 yrs.
- Mood and cognitive performance assessed at 8:00 (baseline) and following inulin or placebo (11:00)
- Mental health and physical symptoms questionnaire

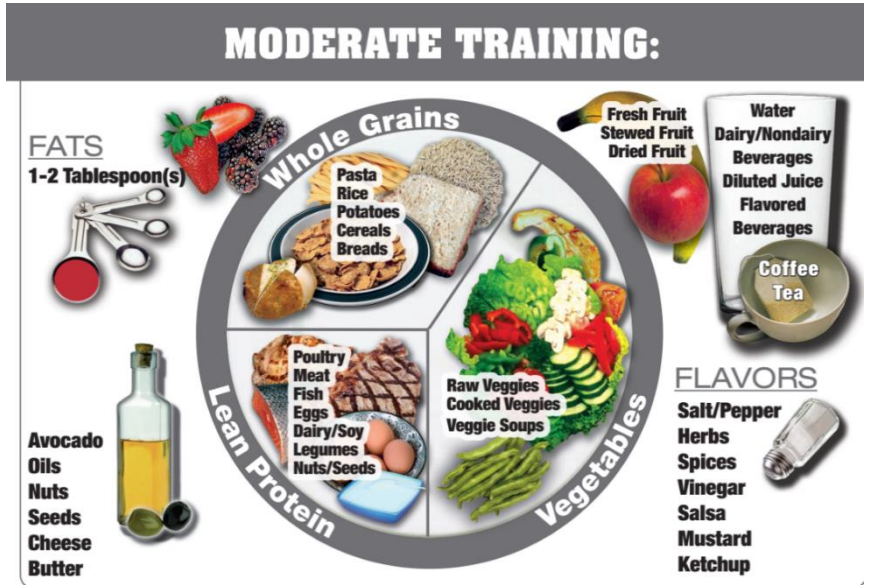
Topline Results

- After consumption of inulin, volunteers felt happier, had less indigestion and were less hungy
- Improvements in episodic memory (recall and recognition) observed after consumption of inulin

Smith AP, Sutherland D, Hewlet P. *Nutrients* 2015

Practical Advice from a Sports Dietitian-Adding Prebiotics to an Athlete's Diet

Incorporating Prebiotics on your Plate



Source: United States Olympic Committee- Athlete's plates

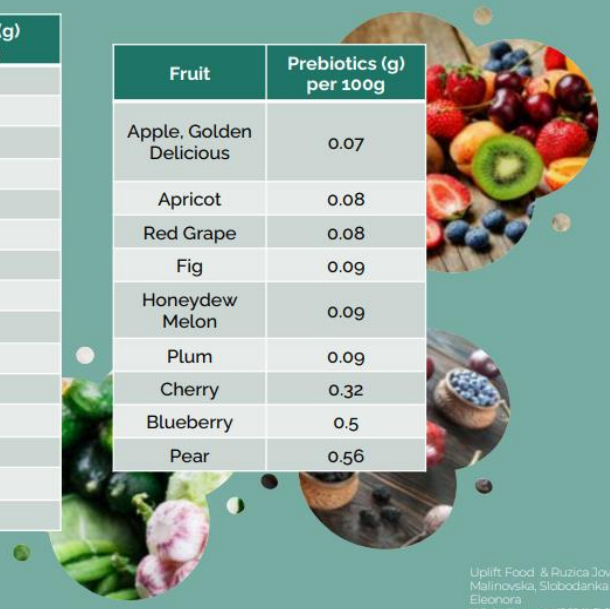
Tools: Helping Athletes Plan for Prebiotics

Prebiotic Levels in Common Fruits and Vegetables

GLOBAL PREBIOTIC ASSOCIATION

Vegetable	Prebiotics (g) per 100g
Beetroot	0.48
Broccoli	0.89
Brussel Sprouts	0.82
Carrot	0
Celery	0
Chard	0
Eggplant	0
Kale	0.51
Lettuce, Green	0
Peas	0
Radish	0
Red Pepper	0
Tomato	0
Yellow Beans	0
Zucchini	0

Fruit	Prebiotics (g) per 100g
Apple, Golden Delicious	0.07
Apricot	0.08
Red Grape	0.08
Fig	0.09
Honeydew Melon	0.09
Plum	0.09
Cherry	0.32
Blueberry	0.5
Pear	0.56



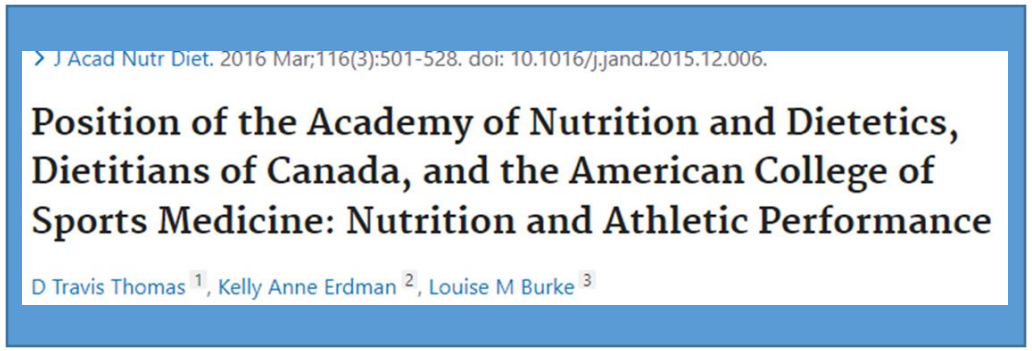
Uplift Food & Ruzica Jovanovic-Malinovska, Slobodanka Kuzmanova & Eleonora Winkelhausen (2014) DOI: 10.1080/10942912.2012.680221

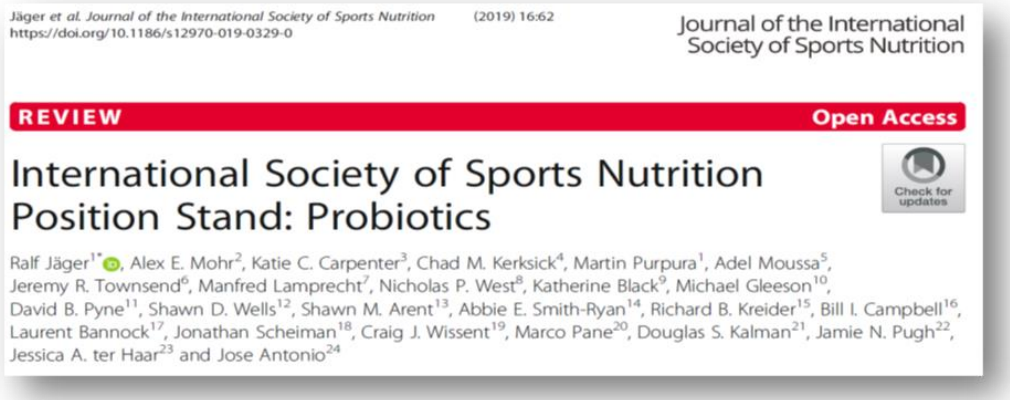
Vegetables Providing the Richest Source of Prebiotics

Vegetable	Prebiotics (g) per 100g (range)
Fennel	0.79
Scallion	4.1
Garlic	1.76 - 6.4
White onion	1.1 - 7.5
Leek	1.07 - 8.0
Dandelion Greens	0.73 - 12.0
Jerusalem Artichoke	1.62 - 15.0
Chicory Root	0.52 - 26.2

Global Prebiotics Association (GPA) HCP Guide

Can we help shape Clinical Practice Guidelines to include Recommendations for Prebiotics?





- **NO** current clinical practice guidelines or guidance on prebiotic use in athletes
- HCPs including RDs/RDNs need guidance on evolving topics in sports nutrition practice
- An interdisciplinary working group maybe needed to implement change

Thomas DT, Erdman KA, Burke LM. *J Acad Nutr Diet* 2016;116(3): 501-528.

Scientific Areas for Exploration

- More gender and sport-specific studies that look at GI health benefit areas when supplementing with specific prebiotics
- Working committees and interdisciplinary groups are needed to shape and update registered dietitian and sports recommendations to include prebiotics
- Outreach to athletic teams to understand current prebiotic supplementation use and how that may impact performance
- How do we identify newer or emerging prebiotics that can help enrich microbial diversity in the gut of endurance athletes or everyday fitness enthusiasts?
  - Gender specificity-not a one size fits all approach
- Validation of a prebiotic supplementation screening tool and tracking device to capture intake and measure its impact on improvement in performance

In Summary

- The gut is an athletic organ and influenced by diet, type/duration of training, and gender
- Gender specific differences exist in the athletic microbiome, but more research is required to tease out taxonomic differences
- Nutrition strategies to help support the athletic microbiome may include prebiotics.
- Updated clinical practice guidelines for RDNs and other HCPs are needed to establish a framework for how to optimize sports performance with prebiotics.
- Prebiotics are promising for gut health support-athletes should consider consultation with a qualified HCP when including them in their daily diet.

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Extras

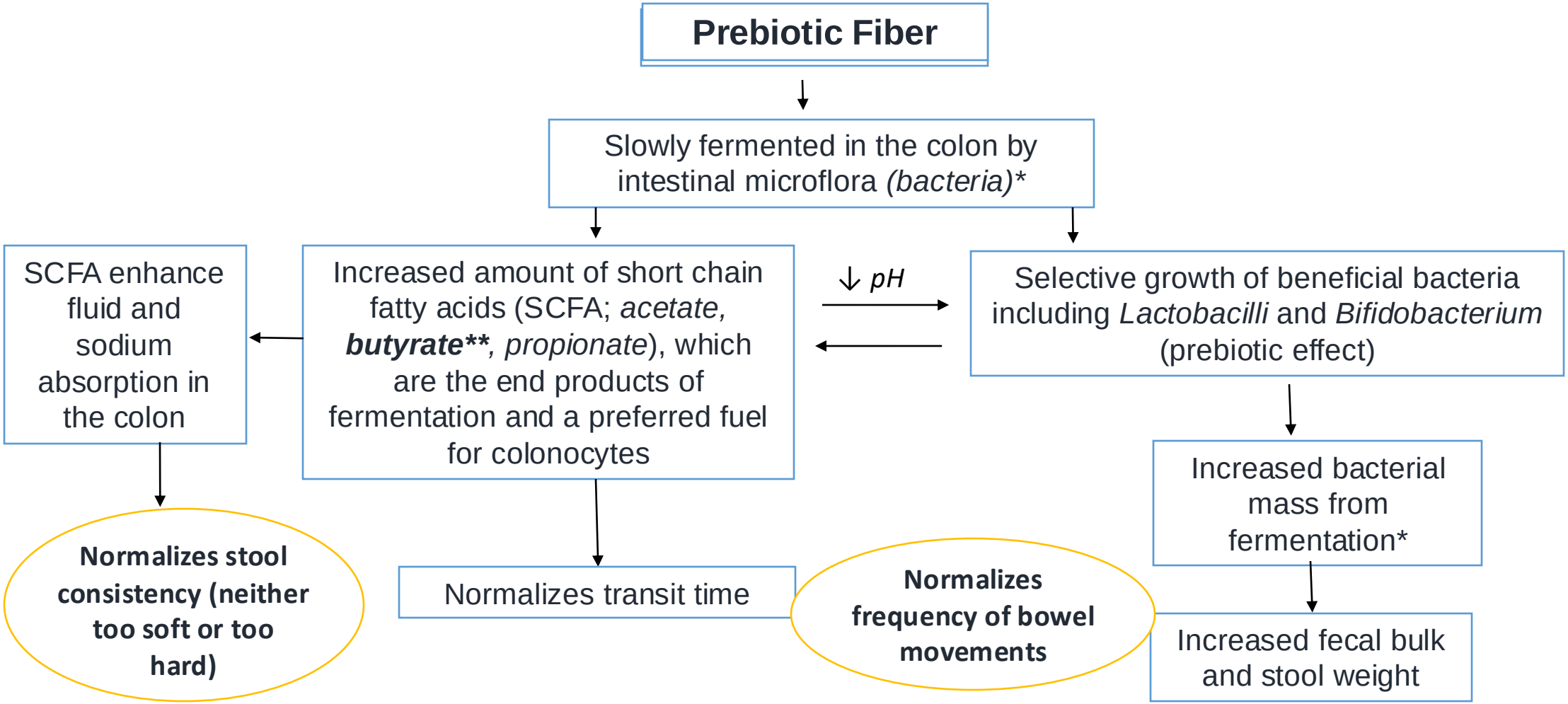
How does Exercise influence the Gut?

- ✓Digestion and absorption
- ✓Contributes to immune function
- ✓Communicates with the brain via gut-brain axis

- ✓Exercise influences gut microbiota, increases α-diversity and microbial metabolites such as short-chain fatty acids (SCFAs)
- ✓SCFAs are utilized as fuel by colonocytes or absorbed into systemic circulation
- ✓In the skeletal muscle, SCFAs can be oxidized, incorporated into glucose via gluconeogenesis or increase the bioavailability of glucose, glycogen and fatty acids during exercise

Pugh J, et al. Eur Jour Sports Sci 2022; 5:755-764.
Hughes R.L. *Adv Nutr.* 2021; 12(6): 2190-2215.

Prebiotics: Scientific Proposed Mechanism(s) of Action



**50-60% of human fecal mass is composed of bacteria, about 30 grams of bacteria are made for every 100 g carb fermented **Colonicepithelial cells preferentially use butyrate as an energy source (fuel) *From-Stephen A.M. and Cummings J.H. The Microbial Contribution to Human Fecal mass J Med Microbiol 1980; 13; 45-56.*

Rao TP, Quartarone G. Role of guar fiber in improving digestive health and function. *Nutrition* https://doi.org/10.1016/j.nut.2018.07.109

Slavin J. Fiber and Prebiotics: Mechanisms and Health Benefits *Nutrients* 2013; 5:1417-1435.

Recommendations for Preparing the Gut for Competition

Tips for Preparing the Gut for Competition
1. Get fit and acclimatized
2. Stay hydrated & practice your hydration strategy during training
3. Avoid over-nutrition before and during exercise
4. Limit high-energy, hypertonic foods and drinks (7-10% CHO)
5. Avoid high-residue and high-fiber foods before exercise
6. Avoid the use of NSAIDs, alcohol, caffeine, antibiotics, and supplements before and during exercise
7. Urinate and defecate prior to exercise

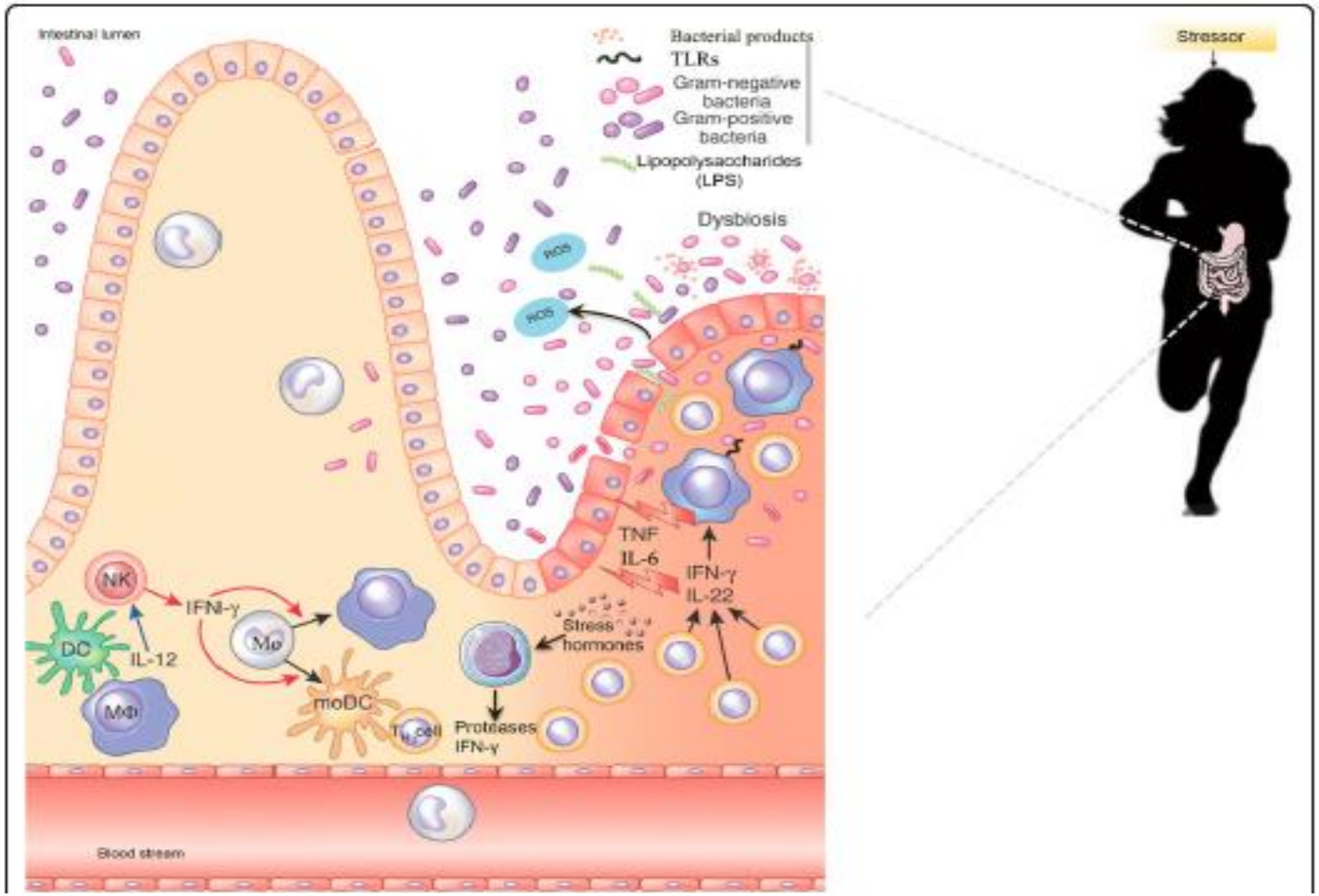
Ho G. Curr. *Sports Med. Rep.* 2009; 8(2): 85-91.
Murray R. Curr. *Sports Med. Rep.* 2006; 5: 161-164.

GI Physiology during Exercise

- Blood flow shifts away from the GI tract towards the active muscles and lungs
- Decreased gut blood flow relaxes gut tone and may increase the passage of colonic contents into the rectum
- Gastric emptying rate is reduced
- A 75% reduction in blood flow with long duration activity causes portions of the intestine to lose functional integrity and increase membrane permeability
- Increased permeability initiates inflammatory events that alter gut structure and function, may result in bloody stool

Brouns F, Beckers E. *Sports Med* 1993; 15(4): 242-57.

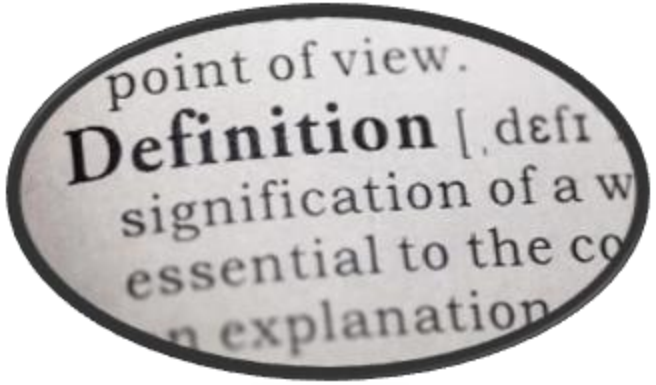
Gastrointestinal Disruption During High-Intensity Exercise



Clark and Match. *J Intl. Soc. of Sports Nut*. 2016;13:43.

Endurance Activity and GI Distress

- “A GI problem that can impair performance and possibly prevent athletes from winning or finishing a race” (de Oliveira EP and Burini RC, 2014)
- “Exercise-induced and associated with lower abdominal symptoms such as diarrhea, bloating, abdominal pain, and flatulence” (Lis, Stellingwerf, Kitic, Fell and Ahuja, 2018)
- “A pervasive problem in ultra-distance runners including symptoms such as nausea, vomiting, abdominal cramping, and diarrhea-sometimes bloody” (Stuempfle, Hoffman and Hew-Butler, 2013)



GI Distress is a Widespread Problem in Endurance Athletes

de Oliveira, E.P. *Sports Med* 2014, Lis et al. *Am Coll Sports Med* 2018
Stuempfle KJ, Hoffman MD, Hew-Butler T. *Int. J Sp Nut & Ex Metab*. 2013
Ten Haaf et al. *BMJ,* 2014

- 37-47% of runners participating in races between 67-161 km reported nausea, vomiting, cramping and diarrhea
- A survey of marathon runners found that up to 26% reported diarrhea and up to 54% reported fecal urgency
- Prevalence of exercise-induced GI symptoms in runners vary from 25-83% during or after a run
- de Oliveira 2014. GI distress occurs in 30-50% of endurance athletes, with up to 90% of distance runners who experience GI problems related to exercise