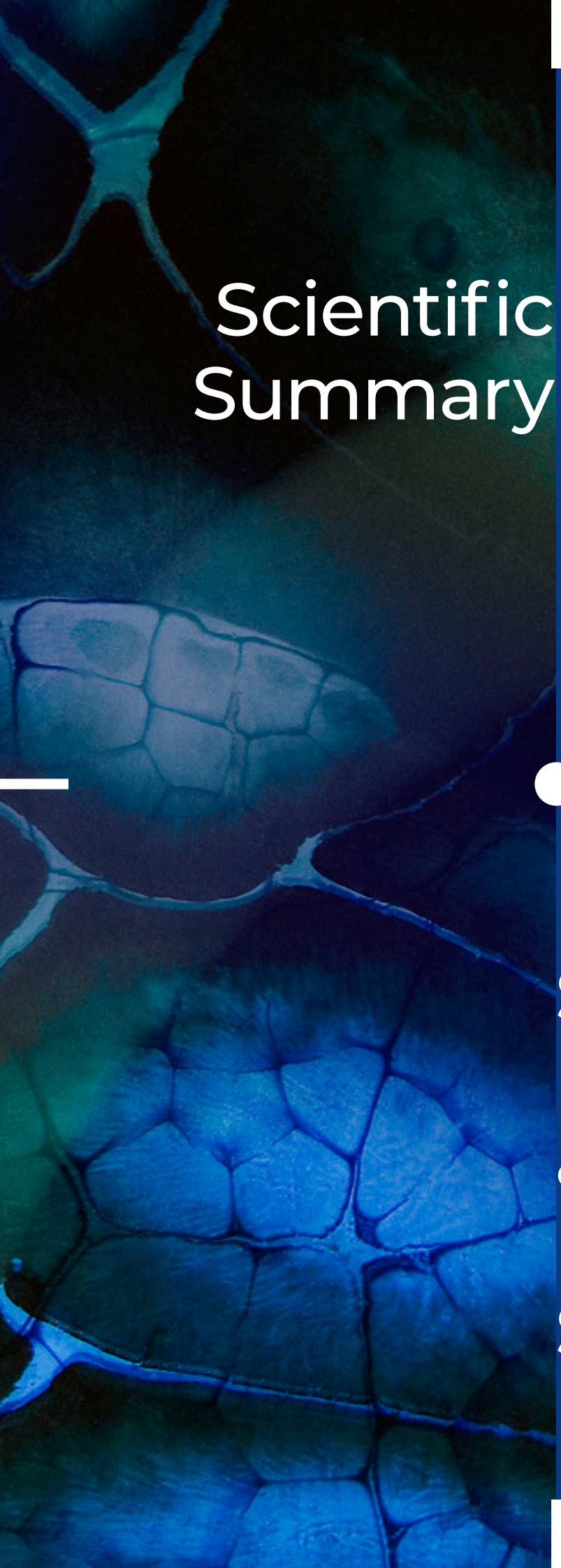

Precision Biotics

Scientific Summary

Sports Performance & the 1714® Probiotic Strain

SCIENTIFIC SUMMARY

Sports Performance & the **1714**® Probiotic Strain

Nutrition is known to play a critical role in athletic performance, influencing an athlete's ability to train, perform and recover. To date, much of the focus has been placed upon identifying the optimal types, quantity and timings of macronutrient intake. More recently the influence of nutrition upon the gut microbiota has emerged as a new focus for research within the field of sports nutrition and performance[1]. In addition to exploring the effect of dietary patterns upon the gut microbiota, there is growing interest in the potential effects of probiotics on the gut microbiota and performance amongst athletes[2,3]. Recent research has suggested that the *Bifidobacterium longum* **1714**® probiotic strain may be associated with improved cognitive and wellbeing outcomes amongst athletes, which may have important implications for sports performance[4].

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Key Points

- Training and competing athletes may experience substantial psychological and physical stress, which may impact the composition of the gut microbiota, affecting training and performance[1]
- Probiotics may beneficially alter the gut microbiota and offer physical and psychological benefits to athletes through several possible modes of action including:
  - Improved intestinal barrier integrity and function[5]
  - Immune modulation[6]
  - Regulation of neurotransmitter activity[7]
- Robust clinical trials in healthy individuals have demonstrated that the *Bifidobacterium longum* **1714**® probiotic strain is associated with significant improvements in:
  - Anxiety scores and cortisol (stress hormone) output following social stress[8]
  - Brain wave activity correlating to reduced mental fatigue[9]
- Real-world evidence suggests that the **1714**® strain may benefit athletes in real-world settings with observations of improvements in[4]:
  - Cognitive performance (decision making, reaction time and distractibility)
  - Perceived stress
  - Sleep quality and energy levels
- The **1714**® strain has been carefully selected for its safety and efficacy by PrecisionBiotics, who have over 20 years' experience of scientific research and expertise in this field

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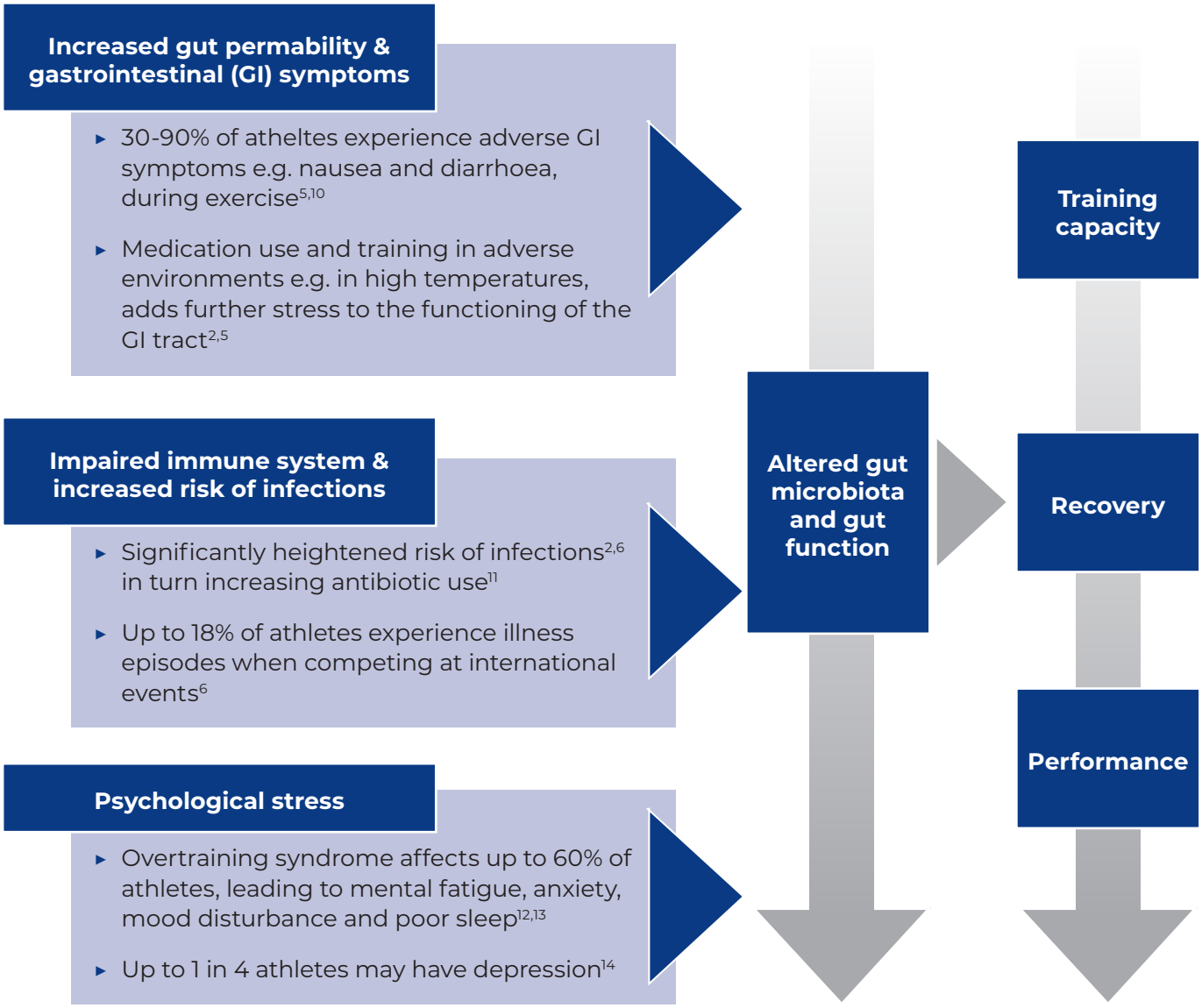
The Gut Microbiome of Athletes

Exercise can have a beneficial effect upon the composition of the gut microbiota. Compared with sedentary people, the gut microbiota of athletes has been found to include a more diverse range of bacteria, with higher levels of the species associated with health benefits, such as bifidobacteria[3,6]. However, athletes face various physical and psychological stressors which can negatively affect the gut microbiota and performance:



The gut microbiota has been identified as a therapeutic target with the potential to improve athletic performance, which is why interest in the role of probiotics in sports nutrition has grown[2,7].

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Probiotics and the Athletic Gut Microbiota

Supplementation with probiotics may confer benefits to the athlete through one or more potential probiotic mechanisms of action including:

- **Intestinal Barrier Function Support.** Increased production of short chain fatty acids by the gut microbiota, the main fuel source for the cells in the gut, may strengthen the lining of the gut and reduce entry of pathogens into the GI tract[2,5]
- **Immune System Modulation.** Altered production and function of immune cells e.g immunoglobins and lymphocytes, leading to enhanced innate and acquired immune responses to pathogens[2,11,15]
- **Gut-Brain Axis Communication.** Neurotransmitters produced by the gut microbiota e.g. serotonin and tryptophan, may directly influence brain activity and cognitive function via the gut-brain axis communication pathway[7,11,16]

The modulation of the gut microbiota through probiotic supplementation may have important implications for athletic training capacity and performance, which in turn may bring further benefits to the athlete (Figure 1).

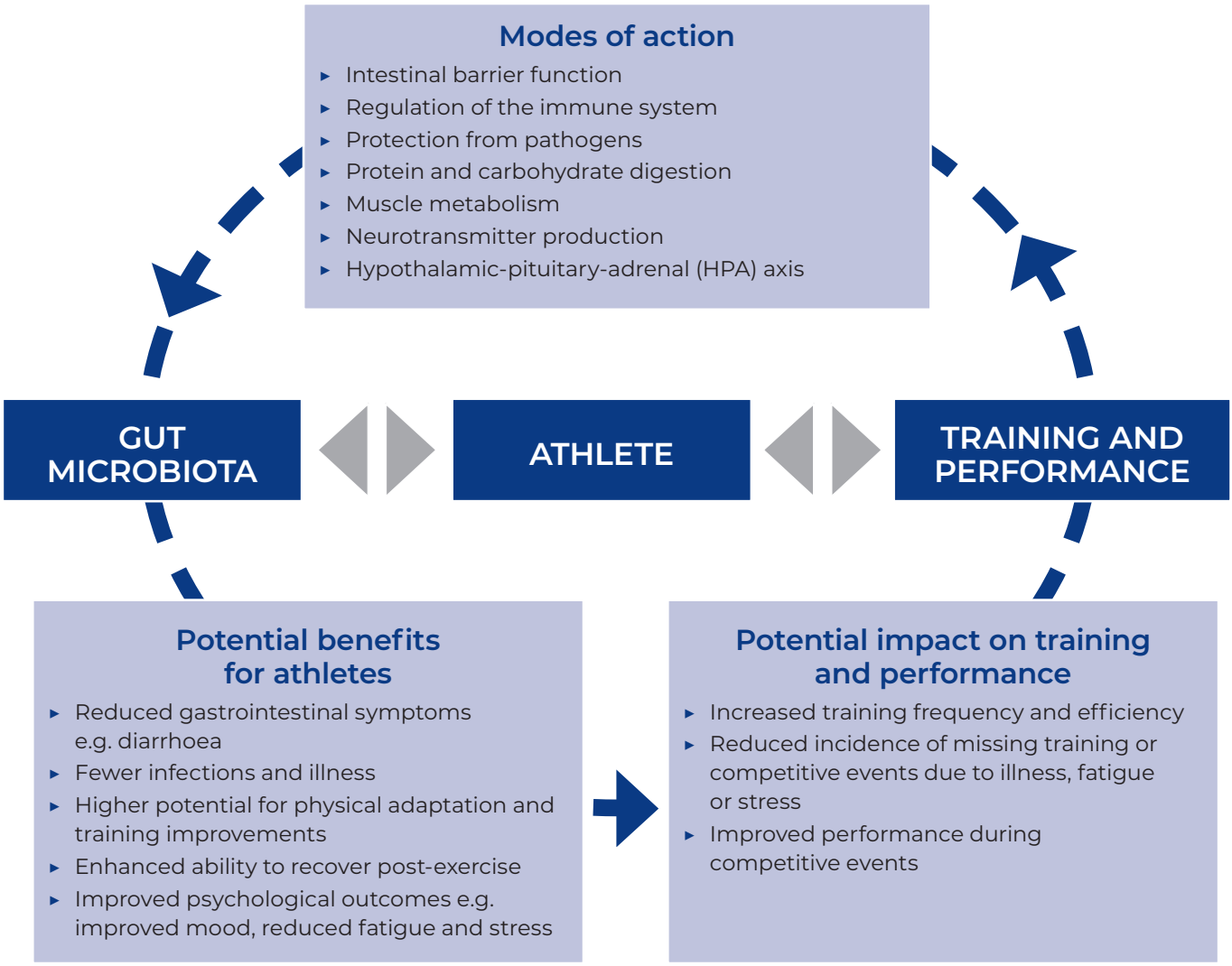

Figure 1. Proposed relationships, mechanisms of action and benefits of probiotic supplementation in athletes[1,2,7,16]

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Guidance for the Use of Probiotics in Sports

The **International Society of Sports Nutrition** and the **International Olympic Committee** acknowledge that selected probiotics may provide clinical benefits to athletes, with the potential to improve their performance[2,17]. The probiotic effects, however, are strain specific and athletes are advised to select probiotic supplements containing bacterial strains that have clinical evidence to support their effectiveness for the particular clinical outcome required[2].
The *Bifidobacterium longum* **1714**® strain has been associated with beneficial effects on cognitive performance and stress response in healthy adults and athletes, with important implications for athletic performance.

Clinical Trials of the *Bifidobacterium longum* 1714® Strain in Healthy Adults

Clinical trials[8,9] comparing the **1714**® strain to placebo in healthy adults have demonstrated significant cognitive benefits including*:

*Further information about the clinical trials can be found in '**Stress & the 1714® Probiotic Strain' Clinical Evidence Summary**.

More recently, focus has shifted to investigating if these benefits are also observed in real-world settings. Such studies generate valuable 'real world evidence'[18] and have been recommended for the investigation of probiotic efficacy in athletes[17].

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Real World Evidence of the *Bifidobacterium longum* 1714® Strain Use in Athletes

An athlete experience programme evaluated cognitive performance and wellbeing outcomes amongst 35 athletes who received a daily probiotic supplement containing the **1714**® strain and B vitamins for 8 weeks[4]. The following benefits were associated with the **1714**® strain supplementation[4]:

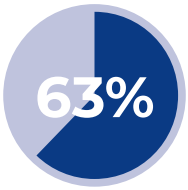
Significant improvements in cognitive performance

Significant improvements in reaction time (4% average group improvement, p=0.008)

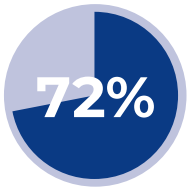
Significant improvements in decision making (5% average group improvement, p=0.006)

Improvements in distractibility (3% average group improvement, not statistically significant)

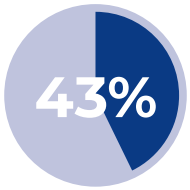
Percentage of athletes showing an improvement in cognitive performance outcomes:



Reaction time



Decision Making



Distractibility

Significant improvements in wellbeing

66%
of athletes reported an improvement in perceived stress, with a 6% average improvement in score (p=0.15)

58%
of athletes reported an improvement in sleep quality

54%
of athletes reported an improvement in energy levels

Implications for Athletic Performance

Even small improvements in physical or psychological performance are of great importance for elite athletes, for whom the difference between 1st and 2nd place can be marginal (Table 1). Athletes may benefit from the use of strain-specific probiotics as part of their nutritional regimen.

Table 1. Percentage margin of victory between 1st and 2nd place in selected competitions at the 2016 Olympics in Rio[19]

	Women's cycling time trial	0.21%		Men's 100m	0.82%
	Women's rowing eight	0.69%		Men's 100m breaststroke	2.73%

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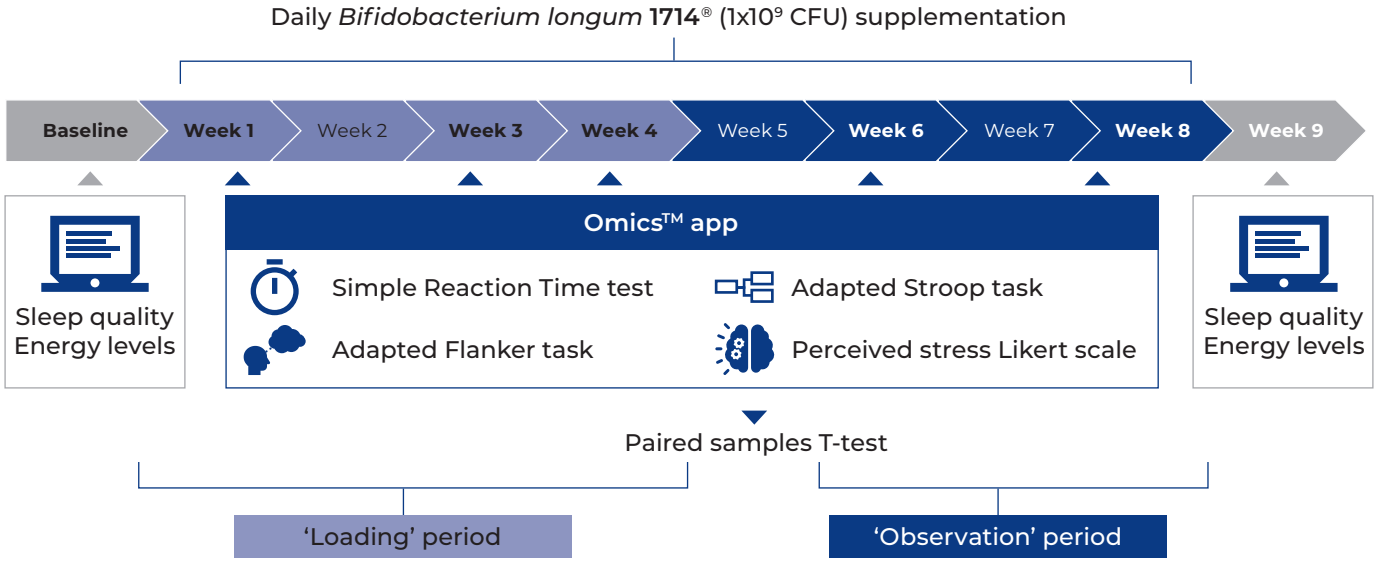
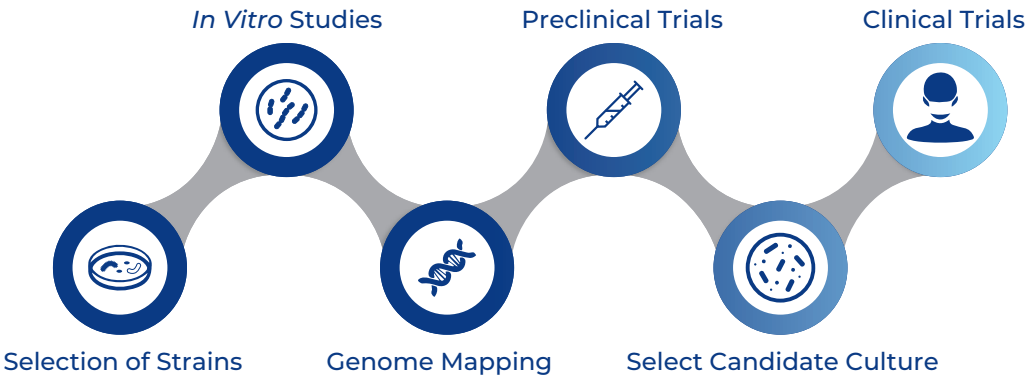
Overview of 1714® Real World Evidence Programme Methodology

A single-armed interventional study in which 35 athletes, referred by their nutritionist or coach, volunteered and completed an eight-week athlete experience programme[4]. The athletes received daily probiotic supplementation containing B vitamins and the **1714®** strain at 1 x 10^9 (one billion) colony forming units (CFU) for eight weeks. At weeks 1, 3, 4, 6 and 8, validated tests (Simple Reaction Time test, the adapted Stroop task to measure decision-making ability and the adapted Flanker task to measure distractibility) adapted for the Omics™ smart phone app measured cognitive performance, and a 10-point Likert scale measured perceived stress. Data collected in the 'loading' period during weeks 1-4 was compared to data collected during the 'observation' period during weeks 6-8. Perceived sleep quality and energy levels were also measured (using an online survey with 6-point Likert scales) at baseline and week 9.



The Precise Approach to Probiotic Development

For over twenty years, PrecisionBiotics has discovered and developed unique probiotic strains in partnership with scientists and clinical experts from a world-leading centre of research into the microbiome and gut-brain axis - the APC Microbiome Institute, University College Cork, Ireland. This follows a robust process to develop targeted probiotics:



The result is safe, effective, evidence-based probiotic supplements with targeted strains selected for their specific action in the specific condition.

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Summary

Psychological and physical stressors are common amongst athletes, with negative consequences for performance. Emerging evidence has highlighted the role of the gut microbiota in regulating the response to stress and cognitive performance, and the potential therapeutic benefits of probiotic supplementation. Clinical evidence has shown that the **1714**® strain may be effective at helping to manage every-day stress and reducing mental fatigue amongst healthy adults. More recently, real-world evidence suggests that the **1714**® strain may be associated with improvements in the cognitive performance, stress and wellbeing of athletes. These findings are of importance to athletes as even marginal improvements can have significant benefits on sporting performance and give athletes the competitive edge. Further research is needed to understand the applications of specific probiotic strains to the athletic population and their modes of action.

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