

# The analytical challenges of anti-doping analysis

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The development of new anti-doping analyses presents a fascinating and ever-changing set of bioanalytical challenges to those who endeavor to devise tests to detect prohibited substances used by athletes. Perhaps unlike any other field of analysis, anti-doping analysis is one with a constantly moving target; as new analyses are developed, new doping techniques move to the forefront. This “arms race” can be seen in both the evolution of doping methods, from synthetic steroids to recombinant human proteins, and the associated tests, from gas chromatography to specialized immunoassays.

The challenges associated with anti-doping analysis are growing ever more complex, as more and more compounds become available, which not only mimic the function of endogenous compounds in terms of function, but also become almost indistinguishable in their chemistry. The development of new analytical methods to identify and quantify the presence of such compounds, likely at very low concentrations, requires great analytical skill and knowledge from both chemical and biochemical analysis perspectives. Additionally, there is the continuous challenge of identifying the next dopant and developing a test for it before it can become widely used. Fortunately, there are a growing number of scientists dedicating their analytical efforts to tackling these challenges and bringing a range of new tools and techniques to bear in the process.

This topical collection is focused on the recent advances that have been made in anti-doping analysis. To a certain extent, the focus of this collection has been directed towards the use of novel or emerging techniques and methods for anti-doping analysis. Although it is without question that mass

spectrometry, coupled with chromatographic separation, is the dominant analytical technique in the field, it is becoming somewhat limited in its applicability. The next generations of doping agents, those that are recombinant forms of endogenous compounds, will require new tools for their identification. In this collection, the reader will find critical reviews and new research articles by research groups dedicated to developing some of these new tools, such as the detection of gene transfer vectors, a lateral flow assay for erythropoietin, and a DNA-based approach to identifying blood transfusions. The role of mass spectrometry, of course, cannot be neglected, particularly with advances in its coupling with novel sampling approaches, such as solid-phase microextraction, and its use in the detection of the latest small-molecule doping agents. Although urine may be the simplest and commonest fluid sampled for anti-doping tests, the analysis of blood samples is growing. There are inherent challenges with this matrix which are not present with urine samples; however, these are being overcome by many research groups to yield new modes of dopant analysis. Additionally, this collection contains a research article on the identification of doping agents in equine athletes, lest we forget that humans are not the only athletes who may be doped.

As the guest editor of this special collection, I hope that as the reader of these contributions you are inspired to consider how your own research may assist in the ongoing challenges of anti-doping analysis. The challenges in anti-doping analysis are significant and continue to evolve; therefore, those at the forefront of analytical and bioanalytical research need to work together to devise the next generation of tests to overcome these challenges.

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