Introduction
Differences in the DNA sequence between humans are responsible for much of the variation in sports- and exercise-related traits. For example, the heritability (the proportion of phenotypic variation in a population which is due to intra-individual genetic variation) may be as high as 50% for maximal oxygen uptake (VO_{2max}) (Bouchard et al., 1998) and its trainability (Bouchard et al., 1999). However, we know comparatively little about the molecular variations in the DNA sequence that add up to the often 50% or more estimated heritability for major sport- and exercise-related traits such as cardiovascular fitness, strength, maximal-intensity exercise ability and muscle fibre composition (reviewed in Hagberg et al., 2011), although the science is progressing. Consequently, an era where genetic testing in sport and exercise contexts becomes commonplace is approaching, and this raises several ethical concerns. This statement summarises an original BASES position paper on this topic (Williams et al., 2007).

Background and evidence
Scientific progress
Sport and exercise genetics (also referred to as athletogenomics or kinesiogenomics) remains in its infancy, with a requirement for greater replications of the hundreds of genotype-phenotype associations reported to date (Hagberg et al., 2011). Examples of such associations include African ancestry between genetic variants and aspects of exercise performance including an insertion/ deletion (I/D) polymorphism in the ACE gene associated with the training responsiveness of oxygen uptake during exercise (Lander, 2011). Sport and exercise scientists should seek to generate sufficient evidence to determine whether a ‘personalised medicine’ or ‘exercise’ for all (or some combination of the two) is the most effective strategy to prevent and treat disease.

Ethical concerns
Human genetic research requires ethics committee approval and must comply with the World Medical Association’s Declaration of Helsinki. Recommendations of bodies such as the Human Genetics Commission should also be followed. We conclude that the ethical concerns about genetic research itself are relatively small because of the scrutiny imposed by ethics committees and other bodies.

One specific aspect of genetic research is the sport and exercise sciences that is potentially problematic is the investigation of inter-racial differences. Some scientists are fascinated by the remarkable East African endurance athletes and African sprinters of West African descent, and this has stimulated research aimed at identifying the reasons for this success. However, using molecular-genetic research to play up the significance of these differences might inadvertently help others perpetuate racial stereotypes about race, performance and intelligence, and some people reject genetic research where ethnic groups are compared for this reason. Yet some ethnic groups are underrepresented in clinical trials, despite suffering more from some diseases. Thus, there are both advantages and disadvantages for investigating genetic differences between ethnic groups.

Looking beyond research per se, towards an era where our understanding of the role of genetics in sport and exercise is greater than now, there are various applications that raise ethical concerns. In sport, genetic performance tests to be treated differently from more traditional physiological tests requires the identification of fundamental differences between traditional and genetic performance tests. This reflects the “genetics exceptionalism” concept, which concerns whether genetic testing is a normative requirement beyond traditional physiology and that genetic performance tests are similar in many ways, but we see two important differences. The first is that unexpected, major disease associations are likely to be detected after a genetic test has been conducted than after a traditional performance test. Genetic counselling before a genetic test can help to prepare an individual for the potential implications of such findings. The second difference is that genetic tests (i.e., tests of DNA sequence) can be carried out as soon as genomic DNA can be obtained; in sharp contrast to more traditional performance tests requires the data are special and thus require bespoke regulation. Genetic and exercise context (with the possible exception of pre-participation risk screening) should only be performed on mature individuals who fully understand the relevant issues and a system of counselling should be introduced.

Pre-participation risk screening should not be obligatory and the confidentiality of such testing to be ensured.

Molecular and exercise scientists should be aware of the risk that a ‘personalised medicine’ public narrative could undermine the “individualised medicine” public narrative could undermine the potential for elite human physical performance. Similarly, one could envisage care strategies (exercise prescription) be used to place greater emphasis on exercise for those likely to benefit.

Conclusions and recommendations
The future of sport and exercise science will become increasingly focused on genetic research and testing as the relevant molecular technologies become faster, cheaper and more widely available (Lander, 2011). Sport and exercise scientists need to ensure that they keep abreast with genomic science to capitalise on recent and anticipated findings in an ethically acceptable manner. It is recommended that:

• Sport and exercise scientists should maintain their awareness of potential unwanted consequences of genetic information and of the potential misuse of genetic data to justify discriminatory views or practices. Sport and exercise scientists should engage knowledgeably in public debates to minimise those risks.

• Genetic testing in the sport and exercise context (with the possible exception of pre-participation risk screening) should only be performed on mature individuals who fully understand the relevant issues and a system of counselling should be introduced.

References
Ahmote, J. et al. (2009). The combined impact of metabolic score, maximum acceleration and endurance status on Vo_{2max} in athletes. Human Motor, 12, 751-759.
Bouchard, C., Sarzynski, M.A., Rice, T.K., Kraus, W.E., Church, T.S., Sui, Y., Yao, D.C. & Rankinen, T. (2011). Genetic epidemiology of VO_{2max}, systolic blood pressure or fasting blood glucose of a patient test conducted on an embryo will yield the same information as

For more information, please see two important differences. The first is that unexpected, major disease associations are likely to be detected after a genetic test has been conducted than after a traditional performance test. Genetic counselling before a genetic test can help to prepare an individual for the potential implications of such findings. The second difference is that genetic tests (i.e., tests of DNA sequence) can be carried out as soon as genomic DNA can be obtained; in sharp contrast to more traditional performance tests requires the data are special and thus require bespoke regulation. Genetic and exercise context (with the possible exception of pre-participation risk screening) should only be performed on mature individuals who fully understand the relevant issues and a system of counselling should be introduced.

Pre-participation risk screening should not be obligatory and the confidentiality of such testing to be ensured.

Molecular and exercise scientists should be aware of the risk that a ‘personalised medicine’ public narrative could undermine the “individualised medicine” public narrative could undermine the potential for elite human physical performance. Similarly, one could envisage care strategies (exercise prescription) be used to place greater emphasis on exercise for those likely to benefit.

Conclusions and recommendations
The future of sport and exercise science will become increasingly focused on genetic research and testing as the relevant molecular technologies become faster, cheaper and more widely available (Lander, 2011). Sport and exercise scientists need to ensure that they keep abreast with genomic science to capitalise on recent and anticipated findings in an ethically acceptable manner. It is recommended that:

• Sport and exercise scientists should maintain their awareness of potential unwanted consequences of genetic information and of the potential misuse of genetic data to justify discriminatory views or practices. Sport and exercise scientists should engage knowledgeably in public debates to minimise those risks.

• Genetic testing in the sport and exercise context (with the possible exception of pre-participation risk screening) should only be performed on mature individuals who fully understand the relevant issues and a system of counselling should be introduced.

• Pre-participation risk screening should not be obligatory and the confidentiality of such testing to be ensured.

• Molecular and exercise scientists should be aware of the risk that a ‘personalised medicine’ public narrative could undermine the “individualised medicine” public narrative could undermine the potential for elite human physical performance. Similarly, one could envisage care strategies (exercise prescription) be used to place greater emphasis on exercise for those likely to benefit.

Conclusions and recommendations
The future of sport and exercise science will become increasingly focused on genetic research and testing as the relevant molecular technologies become faster, cheaper and more widely available (Lander, 2011). Sport and exercise scientists need to ensure that they keep abreast with genomic science to capitalise on recent and anticipated findings in an ethically acceptable manner. It is recommended that:

• Sport and exercise scientists should maintain their awareness of potential unwanted consequences of genetic information and of the potential misuse of genetic data to justify discriminatory views or practices. Sport and exercise scientists should engage knowledgeably in public debates to minimise those risks.

• Genetic testing in the sport and exercise context (with the possible exception of pre-participation risk screening) should only be performed on mature individuals who fully understand the relevant issues and a system of counselling should be introduced.

• Pre-participation risk screening should not be obligatory and the confidentiality of such testing to be ensured.

• Molecular and exercise scientists should be aware of the risk that a ‘personalised medicine’ public narrative could undermine the “individualised medicine” public narrative could undermine the potential for elite human physical performance. Similarly, one could envisage care strategies (exercise prescription) be used to place greater emphasis on exercise for those likely to benefit.