

İÇİNDEKİ SEN

“Sporda Bilinen Gen Gerçeđi”

Editör

Prof. Dr. Ümit ZEYBEK

Yazarlar

Dr. Öğr. Üyesi Murat KASAP

Prof. Dr. Erkut TUTKUN



© Copyright 2024

Bu kitabın, basım, yayım ve satış hakları Akademisyen Kitabevi A.Ş.'ye aittir. Anılan kuruluşun izni alınmadan kitabın tümü ya da bölümleri mekanik, elektronik, fotokopi, manyetik kağıt ve/veya başka yöntemlerle çoğaltılamaz, basılamaz, dağıtılamaz. Tablo, şekil ve grafikler izin alınmadan, ticari amaçlı kullanılamaz. Bu kitap T.C. Kültür Bakanlığı bandrolü ile satılmaktadır.

ISBN
978-625-375-315-3

Yayın Koordinatörü
Yasin DİLMEN

Kitap Adı
İÇİNDEKİ SEN
“Sporda Bilinen Gen Gerçeği”

Sayfa Tasarımı
Akademisyen Dizgi Ünitesi

Editör
Ümit ZEYBEK
ORCID iD: 0000-0001-8403-2939

Kapak Tasarımı
Fatih ALTIN

Yayıncı Sertifika No
47518

Yazarlar
Murat KASAP
ORCID iD: 0000-0003-4740-7118

Baskı ve Cilt
Gökтуğ Ofset

Erkut TUTKUN
ORCID iD: 0000-0003-4233-7798

Bisac Code
SPO000000

DOI
10.37609/akya.3494

Kütüphane Kimlik Kartı
Kasap, Murat [ve başkaları...].
İçindeki Sen “Sporda Bilinen Gen Gerçeği” / Murat Kasap, Erkut Tutkun; ed. Ümit Zeybek.
Ankara : Akademisyen Yayınevi Kitabevi, 2024.
246 s. : tablo, resim. ; 135x210 mm.
Kaynakça var.
ISBN 9786253753153

GENEL DAĞITIM
Akademisyen Kitabevi A.Ş.

Halk Sokak 5 / A
Yenişehir / Ankara
Tel: 0312 431 16 33
siparis@akademisyen.com

www.akademisyen.com

İÇİNDEKİLER

GENETİK.....	1
İNSAN GENOM PROJESİ (İGP).....	3
MODERN GENETİK	6
CRISPR İkizleri Lulu ve Nana: Etik Çıkarımlar ve Bilimsel Atılımlar.....	7
GENETİK YAPININ SPOR PERFORMANSINA ETKİSİ.....	10
GENETİK ALANINDA KULLANILAN GENEL KAVRAMLAR	12
Gen Nedir?	12
Genetik Nedir?.....	15
Genetik Kod (DNA) nedir?	15
Gen sıklığı Nedir?	15
Gen Ailesi Nedir?.....	16
Gen Haritalaması Nedir?.....	16
Gen Tedavisi Nedir?	16
Genokopi Nedir?	16
Epigenetik Nedir?	16
Telomer Nedir?	17
Allel Nedir?.....	17
Antisipasyon Nedir?	17
Dominat Gen Nedir?	18
Resesif Gen Nedir?	18
Fenotip Nedir?.....	18
Polimorfizm Nedir?.....	18
SNP (Single Nucleotide Polymorphism-Tek Nükleotid Polimorfizmleri) Nedir?.....	18

Genomik Nedir?.....	19
Metabolomik Nedir?.....	20
Kromozom Nedir?	20
Kromatin, DNA ve Histon Proteinleri nedir?.....	20
Kromotit Nedir?	22
Kromatit Yapısı ve İşlevi.....	23
Mutasyon Nedir?	25
Gen testleri nasıl yapılır?.....	28
BESLENME VE GENETİK	29
EPİGENETİK	39
SPOR VE GENETİK	41
TÜRKİYE'DE SPOR GENETİĞİ	45
DAYANIKLILIK İLE İLİŞKİLİ GENLER	75
GENLER, SPOR VE DEPRESYON ARASINDAKİ İLİŞKİYİ KEŞFETMEK.....	136
SPORTİF PERFORMANS VE GEN RAPORLAMASI İLE GENEL DEĞERLENDİRME	159
GEN VE AMİOSİT EŞLEŞMESİ	168
KAYNAKLAR	211

ÖNSÖZ

İnsan Genom Projesi ile başlayan kapsamlı gen macerası, araştırmalarla bambaşka boyutlara ulaşmıştır. Günümüzde tedavi edilemeyen hastalıklarının tedavi edilebileceği, yeni ve farklı yaklaşımlarla şekillendirilebilen sporcular, gıdalar, nesnelere bilim dünyası gün geçmiyor ki yeni buluş açıklamasin. Spor dünyası da bu yeni araştırmaları "Sporda yetenek" konusunda kullanıyor. Bu araştırmalar destekçi bulduğu kadar eleştirilere de sebep oluyor.

Sporda performans ve yetenek doğuştan mı var yoksa planlı ve programlı çalışmalar sonucunda kazanılan bir durum mu? Bu soru daha çok tartışma konusu olmaya devam edecek gibi duruyor. Son yıllarda genetik biliminin çalışma sonuçları, atletik performansı etkileyen genlerin tespit edilmesi, uygulanan özel programların spor branşına ve antrenman programına verdiği fizyolojik tepkilerin ölçülebilmesi ilginç saptamalara da sebep olmuştur.

Genetik test, birey henüz spora başlamadan dahi önemli bilgiler verebilmektedir. Bu kapsamda genetik test, araştırmacılar tarafından yetenek seçimi aşamasında bireyin yatkın olacağı spor türü hakkında bilgiler veren alternatif bir yöntem olarak gösterilmektedir. Ancak, mevcut bilgiler ve teknolojik bilgilerle 3-5 gen veya varyantı ile yapılan sözde genetik taramalar, kesin olarak atletik başarıyı öngörmek veya elemek için kullanılmaz, kullanılmamalıdır. Çünkü genetik ilişkilerin araştırıldığı çalışmalarda, nüfus düzeyinde atletik performans özellikleriyle ilişkili faktörlerin ortaya çıktığı ve herhangi bir değişkenin bir birey için göreceli olarak daha değişken olabileceği unutulmamalıdır.

Tüm çalışmalar, erken yaşta spora ilgi duyan çocukların ilerde başarılı bir sporcu olacağı önermesi ile başlamış, ardından bazı bilimsel bilgilerin varlığını kullanarak sportif kehanetlerle bulunma noktasına gelinmiş olması ahlaki değerleri sorgulatır hale getirmiştir.

Olimpiyatlara katılan sporcuların yaşlarının giderek küçülüyor olması, çocukların çok daha erken yaşlarda spora yönlendiriliyor olması bir sır değildir. Tabi ki erken yaşlarda çocukların fiziksel aktivitelere başlatılıyor olması, çocukların hangi sporda hangi alanlarda daha başarılı olabileceğini ön görmek ve onları doğru spora yön-

lendirmek temel sorun olarak karşımıza çıksada, sorunlarla baş edemeyen, multidisipliner çalışmaktan kaçınan anlayış yine karşımıza sorun yumağı şeklinde çıkmaktadır. Tüm çalışmaları sportif etkinlik veya gol atmak, 100 m. koşturmak, sağlık topu fırlattırmak üzerine yoğunlaşmak ne kadar yanlışsa sadece sağlık ve gen üzerine de yoğunlaşmak o kadar yanlış olacaktır. Çünkü, insan mükemmel yaratılmış adeta mucizevi bir makinedir. Bazen mucizeler de tanımları alt üst edebilmektedir.

Genetik özellikler, aileler ve antrenörler için başarılı sporcular yetiştirmede kılavuz oluyor. Genler, çocukları bir spor dalına yönlendirme amacından çok, ilgi duydukları spor dalında hangi alanda daha başarılı olabileceklerini tespit etmede belirleyici rol oynuyor. En başarılı olabileceği spor dalından, spor dalındaki doğru stratejiyi, ideal idman yöntemlerini hatta sakatlık ve iyileşme potansiyelini bile genetik yatkınlıklarından öğrenebilmek mümkün hale geliyor. Gen bilgileri aynı zamanda kişiye özel antrenman, doğru beslenme, besin takviyesi kullanımı, dinlenme süreçlerinin programlaması gibi kişiye özel birçok konuda yardımcı oluyor.”

Gen ve Spor Gerçeği, 2 kaynak kitaptan oluşacak şekilde araştırmalarımızı yaptık. Her bir kitabın hitap ettiği kitlenin farklı olacağını umduğumuz bir kaynakla sizleri buluşturmak istemekteyiz.

Elinize aldığınız 1. Kitap, siz okuyuculara konunun derinlemesine anlatmak yerine, spor alanında öncelikle “ NE ? NASIL ? NİÇİN ? ” sorularının cevaplarını ve bunca zamandır neler yapıldığını gözler önüne sermektir.

2. Kitap ise 2025 yılında, spor ve genin daha üst seviyelerde ki araştırmaların sorgulanması, bulgularının siz okuyucularımızla eleştirel bir bakışla yeni aday genlerin hangi amaçlar için araştırıldığı ve ortaya son 5 yılda hangi bulguların sunulduğunu sizlerle paylaşacağız.

Belki, spor alanı bu yönüyle meslektaşlarımıza derinlemesine eleştiri, sorgulama, hatta bu kitabı daha da derinlemesine genişleterek, hayatında top görmemiş, sahada terlememiş, empati kurarmış “teorik ezberciler” aaaa..... orada bir dur bakalım deme fırsatı verebilir... Keyifli okumalar.

Prof. Dr. Erkut TUTKUN

YAZAR'DAN

Unutulmamalıdır ki, canlılık genlerinin izin verdiği sürece koşabilir, atabilir, zıplayabilir ve yaşayabilir!

Tabiki çevresel faktörler de bu genetik ifadenin üzerinde kalıcı olmasa da çok fazla söz sahibidir,. Devamı kitabın içerisinde.

Gelin beraber bu genetik penceresinden spor nasıl gözüküyor bir bakış atalım.

Dr. Öğr. Üyesi Murat KASAP

EDİTÖR'DEN

Sporla yaratılan yarışmacı ortamın bireysel, Sosyo-kültürel ve politik faktörlerin etkisi ile giderek öneminin artması, "fiziksel olarak üstün olmak sportif başarı için yeterlidir " yanlış inancını ortadan kaldırmaktadır. Akademisyenler, spor bilimciler, moleküler alanda çalışma yapan bilim insanları, sporcular, antrenörler, sportif performans katkısı olan fiziksel ve teknik tabanlı özelliklerin yanında genetik alt yapının önemli rol oynadığının önemini kavramaya başlamıştır.

Egzersiz, fiziksel aktivite veya sportif performans.... Bunlardan hangisi ile temasta bulunursanız bulunun vazgeçilmez olguların içinde yer alması gerekenlerden ikisi kişilerin Metabolizma ve Genetik Yapılarıdır.

Zira kas sistemini sadece mekanik ve fizyolojik etkileşimlere sokarak söz konusu aktivasyonları ulaşılmak istenen noktaya getirmek mümkün olmayabilir yada kişinin gerçek potansiyelini yansıtmak konusunda eksikler yaşanabilir.

Peki o zaman tıbbi ve bilimsel yaklaşımlardan oluşan her iki bilgi deposundan yararlanmak gerekmez mi?

Tabii ki evet.....

Ancak dikkat edilmesi gereken noktalar göz ardı edilmeden...

Nedir bunlar?

Öncelikle ne genlerimizi kaderimiz olarak göreceğiz, ne de onları bir kenara atacağız. Evet anne ve babadan gelen genetik alt yapı oldukça etkilidir, lakin her şey değildir. Çevresel faktörler şeklinde nitelendirilebilecek etkenler her an sürpriz yapabilirler...

İşte tam bu noktada "Gensel Performans" kavramı çerçevesinde, bahsi geçen tüm etkileşimleri, "Genin Senindir" yaklaşımını, sportif açıdan ortaya konan eksik yaklaşımları, yanlış yönlendirmeleri, kitap içeriğinde vurgulamak ve spor camiası içindeki tüm bileşenlere dikkat dikkat demek istiyoruz.

Farklılık ve farkındalık oluşturmak dileğiyle....

Prof. Dr. Ümit Zeybek

KAYNAKLAR

1. Abe, D., Doi, H., Asai, T., Kimura, M., Wada, T., Takahashi, Y., ... & Shinohara, K. (2018). Association between COMT Val158Met polymorphism and competition results of competitive swimmers. *Journal of sports sciences*, 36(4), 393-397.
2. Abel, A M., Yang, C., Thakar, M S., & Malarkannan, S. (2018). Natural Killer Cells: Development, Maturation, and Clinical Utilization. <https://doi.org/10.3389/fimmu.2018.01869>
3. Agarwal, A., Zhang, M., Trembak-Duff, I., Unterbarnscheidt, T., Radyushkin, K., Dibaj, P., ... & Schwab, M. H. (2014). Dysregulated expression of neuregulin-1 by cortical pyramidal neurons disrupts synaptic plasticity. *Cell reports*, 8(4), 1130-1145.
4. Ahmetov II, Hakimullina AM, Popov DV, Lyubaeva EV, Missina SS, Vinogradova OL, Williams AG, Rogozkin VA. (2009). Association of the VEGFR2 gene His472Gln polymorphism with endurance- related phenotypes. *Eur J Appl Physiol*,107:95–103.
5. Ahmetov II, Kulemin NA, Popov DV, Naumov VA, Akimov EB, Bravy YR, Egorova ES, Galeeva AA, Generozov EV, Kostryukova ES, Larin AK, Mustafina LJ, Ospanova EA, Pavlenko AV, Starnes LM, Żmijewski P, Alexeev DG, Vinogradova OL, Govo-run VM:(2015). Genome-wide association study identifies three novel genetic markers associated with elite endurance performance. *Biol Sport*; 32
6. Ahmetov II, Naumov VA, Donnikov AE, Maciejewska-Karłowska A, Kostryukova ES, Larin AK, Maykova EV, Alexeev DG, Fedotovskaya ON, Generozov EV, Jastrzębski Z, Żmijewski P, Kravtsova OA, Kulemin NA, Leonska-Duniec A, Martynkova DS, Ospanova EA, Pavlenko AV, Podolskaya AA, Sawczuk M, Alimova FK, Trofimov DY, Govorun VM, Cieszyk P, (2014). SOD2 gene polymorphism and muscle damage markers in elite athletes. *Free Radic Res*;48:948–955.
7. Ahmetov, I I., Egorova, ES., Gabdrakhmanova, LJ., & Fedotovskaya, O. (2016). Genes and Athletic Performance: An Update. *Medicine and sport science/Medicine and sport*, 41-54. <https://doi.org/10.1159/000445240>
8. Ahmetov, II., & Fedotovskaya, ON. (2015). Current progress in sports genomics. *Advances in clinical chemistry*, 70, 247-314.
9. Ahmetov, II., Egorova, ES., Gabdrakhmanova, LJ., & Fedotovskaya, ON. (2016). Genes and athletic performance: an update. *Genetics and sports*, 61, 41-54.
10. Ahmetov, II., Khakimullina, AM., Popov, DV., Missina, SS., Vinogradova, OL., & Rogozkin, VA. (2008). Polymorphism of the vascular endothelial growth factor gene (VEGF) and aerobic performance in athletes. *Human Physiology*, 34, 477-481.

11. Akçamlı, D., Sipahi, S., Yüksel, İ., Kavas, N.C., Polat, T., Sercan, C. & Ulucan, K. (2018). Futbolcularda Peroksizom Proliferatör–Aktive Reseptör Alfa rs4253778 Polimorfizm Dağılımının Belirlenmesi. *Eurasian Research in Sport Science*, 3(2), 75-79.
12. Akkoç, O., Birlik, A.,Doğan,CS.,Ulucan, K., & Kırandı, Ö. (2020). Türk ironman triatlon sporcularında IL-6, HIF1A, MCT1, PPAR-a polimorfizm dağılımının belirlenmesi. *Spor Eğitimi Dergisi*, 4(1), 1-7.
13. Al-Khelaifi, F., Diboun, I., Donati, F., Botrè, F., Abraham, D., Hingorani, AD., Albagha, O., Georgakopoulos, C., Suhre, K., Yousri, N A., & Elrayess, M A. (2019, December 27). Metabolic GWAS of elite athletes reveals novel genetically-influenced metabolites associated with athletic performance. *Scientific reports*, 9(1). <https://doi.org/10.1038/s41598-019-56496-7>
14. Alencar, A., Montes, GC., Barreiro, EJ., Sudo, RT., & Zapata-Sudo, G. (2017, December 4). Adenosine Receptors As Drug Targets for Treatment of Pulmonary Arterial Hypertension. *Frontiers in pharmacology*, 8. <https://doi.org/10.3389/fphar.2017.00858>
15. Allison DB, Barnes S, Garvey WT. Forword from the editors. *Nutrition* 2004; 20:1.
16. Altinisik, J., Meric, G., Erduran, M., Ates, O., Ulusal, A. E., & Akseki, D. (2015). The BstUI and DpnII variants of the COL5A1 gene are associated with tennis elbow. *The American journal of sports medicine*, 43(7), 1784-1789.
17. Aminetzach,Y.T., Macpherson, J.M., & Petrov, D.A. (2005). Pesticide resistance via transposition- mediated adaptive gene truncation in *Drosophila*. *Science*, 309(5735), 764-767.
18. Amir, O., Amir, R., Yamin, C., Attias, E., Eynon, N., Sagiv, M., Sagiv, M., & Meckel, Y. (2007). The ACE deletion allele is associated with Israeli elite endurance athletes. *Experimental physiology*, 92(5), 881–886. <https://doi.org/10.1113/expphysiol.2007.038711>
19. Angelakis G. (2004). Genetics in nutrition and dietetics: a student's perspective. *Top Clin Nutr*. 19: 308-315.
20. Antonucci, A., Marucci, A., Trischitta, V., & Paola, R D. (2022). Role of GALNT2 on Insulin Sensitivity, Lipid Metabolism and Fat Homeostasis. *International journal of molecular sciences*, 23(2), 929- 929. <https://doi.org/10.3390/ijms23020929>
21. Appel, M., Zentgraf, K., Krüger, K., & Alack, K. (2021). Effects of Genetic Variation on Endurance Performance, Muscle Strength, and Injury Susceptibility in Sports: A Systematic Review. <https://doi.org/10.3389/fphys.2021.694411>

22. Asghari, V., Schoots, O., van Kats, S. J. O. R. S., Ohara, K., Jovanovic, V., Guan, H. C., ... & Van Tol, H. H. (1994). Dopamine D4 receptor repeat: analysis of different native and mutant forms of the human and rat genes. *Molecular pharmacology*, 46(2), 364-373.
23. Balberova,OV.,Bykov,EV.,Medvedev,GV.,Zhogina,MA.,Petrov,KV.,Petrova,MM.,&Shnayder,NA.(202 1)Candidate genes of regulation of skeletal muscle energy metabolism in athletes. *Genes*,12(11), 1682.
24. Barrientos, A., Barros, M H., Valnot, I., Rötig, A., Rustin, P., & Tzagoloff, A. (2002). Cyto-chrome oxidase in health and disease. *Gene*, 286 (1), 53-63. [https://doi.org/10.1016/s0378-1119\(01\)00803-4](https://doi.org/10.1016/s0378-1119(01)00803-4)
25. Baserga, R., Peruzzi, F., & Reiss, K. (2003). The IGF receptor in cancer biology. <https://doi.org/10.1002/ijc.11487>
26. Batavani, MR., Marandi, SM., Ghaedi, K., & Esfarjani, F. (2017). Comparison of Muscle-Specific Creatine Kinase (CK-MM) Gene Polymorphism (rs8111989) Among Professional, Amateur Athletes and Non-athlete Karatekas. <https://doi.org/10.5812/asjasm.43210>
27. Belviranlı, M., & Okudan, N. (2018). Exercise training protects against aging-induced cognitive dysfunction via activation of the hippocampal PGC-1 α /FNDC5/BDNF pathway. *Neuromolecular medicine*, 20(3), 386-400.
28. Ben-Zaken, S., Meckel, Y., Nemet, D., & Eliakim, A. (2013). Can IGF-I polymorphism affect power and endurance athletic performance?. *Growth Hormone & IGF Research*, 23(5), 175-178.
29. Ben-Zaken, S., Meckel, Y., Nemet, D., & Eliakim, A. (2017). High prevalence of the IGF2 rs680 GG polymorphism among top-level sprinters and jumpers. *Growth Hormone & IGF Research*, 37, 26- 30.
30. Ben-Zaken, S., Meckel, Y., Nemet, D., Dror, N., & Eliakim, A. (2016). Polymorphism of the IGF-I System and Sports Performance. *Pediatric Endocrinology Reviews: PER*, 13(4), 741-748.
31. Ben-Zaken, S., Meckel, Y., Nemet, D., Kassem, E., & Eliakim, A. (2017). Increased prevalence of the IL-6-174C genetic polymorphism in long distance swimmers. *Journal of human kinetics*, 58, 121.
32. Ben-Zaken, S., Meckel, Y., Nemet, D., Rabinovich, M., Kassem, E., & Eliakim, A. (2015). Frequency of the MSTN Lys (K)-153Arg (R) polymorphism among track & field athletes and swimmers. *Growth Hormone & IGF Research*, 25(4), 196-200.
33. Ben-Zaken,S.,Meckel, Y.,Nemet,D.,& Eliakim,A.(2017). High prevalence of the IGF2 rs680 GG poly- morphism among top-level sprinters and jumpers. *Growth Hormone & IGF Research*, 37, 26-30.
34. Ben-Zaken, S., Eliakim, A., Nemet, D., Rabinovich, M., Kassem, E., & Meckel, Y. (2015). Differences in MCT 1 A 1470 T polymorphism prevalence between runners and swimmers. *Scandinavian journal of medicine & science in sports*, 25(3), 365-371.

35. Bentley, J P., Asselbergs, F W., Coffey, C S., Hebert, P R., Moore, J H., Hillege, H L., & Gilst, WHV. (2010). Cardiovascular Risk Associated with Interactions among Polymorphisms in Genes from the Renin-Angiotensin, Bradykinin, and Fibrinolytic Systems. *PloS one*, 5(9), e12757-e12757. <https://doi.org/10.1371/journal.pone.0012757>
36. Bentley, JP., Asselbergs, FW., Coffey, CS., Hebert, PR., Moore, JH., Hillege, H L., & Gilst, WHV. (2010, September 15). Cardiovascular Risk Associated with Interactions among Polymorphisms in Genes from the Renin-Angiotensin, Bradykinin, and Fibrinolytic Systems. *PloS one*, 5(9), e12757-e12757. <https://doi.org/10.1371/journal.pone.0012757>
37. Berg JM, Tymoczko JL, Stryer L, Clarke ND (2002). *Biochemistry*, 5th edition, New York: W. H. Freeman and Company.
38. Berman, Y., & North, K. (2010). A Gene for Speed: The Emerging Role of α -Actinin-3 in Muscle Metabolism. <https://doi.org/10.1152/physiol.00008.2010>
39. Bertram, JS. (2000). The molecular biology of cancer. *Molecular aspects of medicine*, 21(6), 167-223.
40. Bevan, MW., Uauy, C. (2013). Genomics reveals new landscapes for crop improvement. *Genome Biol* 14, 206 . <https://doi.org/10.1186/gb-2013-14-6-206>
41. Bilen, E., & Eliozy, M. (2023). The relationship between the SLC6A4 gene polymorphism (rs 5- HTTLPR) and aggression in combat athletes. *Journal of ROL Sport Sciences*, 4(4), 1423-1436.
42. Binti Ahmad Yusof, H. (2015). The Effects of Angiotensin I-Converting Enzyme (ACE) I/D and Alpha- Actinin-3 (ACTN3) R/X Gene Polymorphisms on Human Physical Performance and Health within Malaysian Population.
43. Biological Impacts of Climate Change. (2009, March 15). <https://onlinelibrary.wiley.com/doi/10.1002/9780470015902.a0020480>
44. Bondareva, EA., & Negasheva, MA. (2017). Genetic aspects of athletic performance and sports selection. *Biology Bulletin Reviews*, 7, 344-353.
45. Broos, S., Malisoux, L., Theisen, D., Thienen, R V., Ramaekers, M., Jamart, C., Deldicque, L., Thomis, M., & Francaux, M. (2016). Evidence for ACTN3 as a Speed Gene in Isolated Human Muscle Fibers. *PloS one*, 11(3), e0150594-e0150594. <https://doi.org/10.1371/journal.pone.0150594>
46. Brosnan, JT., & Brosnan, ME. (2006). "The role of branched-chain amino acids in energy metabolism." *Nutrition & Metabolism*
47. Brosnan, M. E., & Brosnan, J. T. (2020). Histidine metabolism and function. *The Journal of Nutrition*, 150(1), 2570-2575.
48. Brown JC, Miller CJ, Posthumus M, Schweltnus MP, Collins M. (2011). The COL5A1 gene, ultra- marathon run- ning performance, and range of motion. *Int J Sports Physiol Perform*;6:485–496.

49. Bruchim, I., Attias, Z., & Werner, H. (2009). Targeting the IGF1 axis in cancer proliferation. <https://doi.org/10.1517/14728220903201702>
50. Bulgay, C., Polat, T., Yılmaz, ÖÖ., Aslan, BT., Ergun, MA., & Ulucan, K. (2021). Futbolcularda Anjiyotensinojen (AGT) rs699 Polimorfizm Dağılımının Belirlenmesi. *Kilis 7 Aralık Üniversitesi Beden Eğitimi ve Spor Bilimleri Dergisi*, 5(2), 145-153.
51. Bulgay, C., Sercan Doğan, C., Karapınar, G., Polat, T., Çetin, E., & Ulucan, K. (2021). Farklı Branşlardaki Sporcuların Kollajen Tip V gen (COL5A1) rs12722 Polimorfizmlerinin Dağılımı. *GaziAntep Spor Bilimleri Dergisi*, 6(1).
52. Bulgay, C., Zorba, E., Bayraktar, I., Kazan, H. H., Ulucan, K., & Ergun, M. A. (2023). Association between MCT1 gene polymorphism (rs1049434) with the athletic performance of elite track and field athletes. *SPORMET-RE Beden Eğitimi ve Spor Bilimleri Dergisi*, 21(1), 127-134.
53. Bulgay, C., Zorba, E., Akman, O., Bayraktar, I., Kazan, HH., Ergun, MA., & Ulucan, K. (2022). Evaluation of Association between PPARGC1A Gene Polymorphism and Competitive Performance of Elite Athletes. *Gazi Beden Eğitimi ve Spor Bilimleri Dergisi*, 27(4), 323-332.
54. Buonanno, A., & Fischbach, G. D. (2001). Neuregulin and ErbB receptor signaling pathways in the nervous system. *Current opinion in neurobiology*, 11(3), 287-296.
55. Burrus, V., & Waldor, MK. (2004). Shaping bacterial genomes with integrative and conjugative elements. *Research in microbiology*, 155(5), 376-386.
56. Burton H, Stewart A., (2005) Nutrigenomics: Report of a workshop hosted by The Nuffield Trust and organized by the Public Health Genetics Unit on 5 February 2004. London: The Nuffield Trust: 1-26.
57. Butovskaya, ML., Vasilyev, VA., Lazebny, OE., Suchodolskaya, EM., Shibalev, DV., Kulikov, AM., ... & Ryskov, AP. (2013). Aggression and polymorphisms in AR, DAT1, DRD2 and COMT genes in Datoga pastoralists of Tanzania. *Scientific reports*, 3(1), 3148.
58. Calsyntenin. (2009, December 3). <https://en.wikipedia.org/wiki/Calsyntenin>
59. Çam, F S., Çolakoğlu, M., Tok, S., Tok, I., Kutlu, N., & Berdeli, A. (2010). Personality traits and DRD4, DAT1, 5-HT2A gene polymorphisms in risky and non risky sports participation. *Türkiye Klinikleri Journal of Medical Sciences*, 30(5), 1459-1464.
60. Carlson, HL., Zhang, AS., Fleming, WH., & Enns, CA. (2005). The hereditary hemochromatosis protein, HFE, lowers intracellular iron levels independently of transferrin receptor 1 in TRVb cells. *Blood*, 105(6), 2564-2570. <https://doi.org/10.1182/blood-2004-03-1204>

61. Céspedes, H A., Zavala, K., Vandewege, M W., & Opazo, J C. (2017). Evolution of the $\alpha 2$ - adrenoreceptors in vertebrates: ADRA2D is absent in mammals and crocodiles.. <https://www.sciencedirect.com/science/article/pii/S0016648017300667>
62. Chavez A, de Chavez MM. (2003). Nutrigenomics in public health nutrition: short-term perspectives. *Eur J Clin Nutr* 57 (suppl 1): S97-S100.
63. Chen, Y., Wang, D., Yan, P., Yan, S., Chang, Q., & Cheng, Z. (2019). Meta-analyses of the association between the PPARGC1A Gly482Ser polymorphism and athletic performance. *Biology of sport*, 36(4), 301-309.
64. Chen,C., Sun,Y., Liang, H.,Yu,D., & Hu,S. (2017). A meta-analysis of the association of CKM gene rs8111989 polymorphism with sport performance. <https://doi.org/10.5114/ biolsport.2017.69819>
65. Chiefari, E., Foti, D., Sgarra, R., Pegoraro, S., Arcidiacono, B., Brunetti, F., Greco, M., Manfioletti, G., & Brunetti, A. (2018). Transcriptional Regulation of Glucose Metabolism: The Emerging Role of the HMG A1 Chromatin Factor. <https://doi.org/10.3389/fendo.2018.00357>
66. Childs, E., Hohoff, C., Deckert, J., Xu, K., Badner, J., & Wit, H D. (2008). Association between ADORA2A and DRD2 Polymorphisms and Caffeine-Induced Anxiety. <https://www.nature.com/articles/npp200817>
67. Cięszczyk, P., Eider, J., Ostanek, M., Leońska-Duniec, A., Ficek, K., Kotarska, K., & Girdukas, G. (2011). Is the C34T polymorphism of the AMPD1 gene associated with athletic performance in rowing?. *International journal of sports medicine*, 32(12), 987-991.
68. Cieszczyk, P., Kalinski, M., Ostanek, M., Jascaniene, N., Krupecki, K., Ficek, K.& Maciejewska, A. (2012). Variation in the HIF1A gene in elite rowers. *The Journal of Strength & Conditioning Research*, 26(12), 3270-3274.
69. Cieszczyk, P., Ostanek, M., Leońska-Duniec, A., Sawczuk, M., Maciejewska, A., Eider, J. & Kotarska, K. (2012). Distribution of the AMPD1 C34T polymorphism in Polish power-oriented athletes. *Journal of sports sciences*, 30(1), 31-35.
70. Cięszczyk, P., Sawczuk, M., Maciejewska, A., Jascaniene, N.,Eider, J. (2010). G894T Polymorphisms of Endothelial Nitric Oxide Synthase 3 (NOS3) Influence Endurance Phenotypes. *J. Hum. Kinet*, 24, 73-80.
71. Clarkson, P. M., Hoffman, E. P., Zambraski, E., Gordish-Dressman, H., Kearns, A., Hubal, M., ... & Devaney, J. M. (2005). ACTN3 and MLCK genotype associations with exertional muscle damage. *Journal of Applied Physiology*, 99(2), 564-569.
72. Cocci, P., Pistolesi, L., Guercioni, M., Belli, L., Carli, D., & Palermo, F. A. (2019). Genetic variants and mixed sport disciplines: a comparison among soccer, combat and motorcycle athletes. *Annals of Applied Sport Science*, 7(1), 1-9.

73. Cohen, S., Nathan, JA., & Goldberg, AL. (2014). Muscle wasting in disease: molecular mechanisms and promising therapies. *Nature reviews. Drug discover/Nature reviews. Drug discovery*, 14(1), 58- 74. <https://doi.org/10.1038/nrd4467>
74. Collins KA, Jaspersen SL, Hawley RS. In: S Maloy, and K Hughes, eds. (2013). *Chromosome Movement* Brenner's Online Encyclopedia of Genetics. 2nd Edition ed: Academic Press.
75. Collins, KA., Jaspersen, SL., & Hawley, RS. (201). *Chromosome Movement*.
76. Collins, M. (Ed.). (2016). *Genetics and sports* (Vol. 54). Karger Medical and Scientific Publishers.
77. Control, A. (2001). Human Genome Project. http://web.archive.org/web/20200118013419/https://en.wikipedia.org/wiki/Human_Genome_Project
78. Cooper, GM. (2000, January 1). Heredity, Genes, and DNA. <https://www.ncbi.nlm.nih.gov/books/NBK9944/>
79. Costa, MFD, & Slocombe, RF. (2012). The Use of Angiotensin-I Converting Enzyme I/D Genetic Polymorphism as a Biomarker of Athletic Performance in Humans. *Biosensors*, 2(4), 396-404. <https://doi.org/10.3390/bios2040396>
80. Cupeiro, R., Benito, PJ., Maffulli, N., Calderón, FJ., & González-Lamuño, D. (2010). MCT1 genetic polymorphism influence in high intensity circuit training: a pilot study. *Journal of science and medicine in sport*, 13(5), 526-530.
81. Darnton-Hill I, Margetts B, Deckelbaum R. (2004). Public health nutrition and genetics: implications for nutrition policy and promotion. *Porc Nutr Soc*; 63: 173-185.
82. Dasso, M. (2011). *Cell Biology of Chromosomes and Nuclei*. Wiley, 52(1). <https://doi.org/10.1002/0471143030.cb2200s52>
83. De Camargo, GMF. (2018). The role of molecular genetics in livestock production. *Animal Production Science*, 59(2), 201-206.
84. Dinç N., Yücel, SB., Sayın, MV., & Taneli, F. (2012). Futbolcu ve Sedarterlerde Gnb3 C825t Mütasyonunun Atletik Performansa Etkisi. *Spor Hekimliği Dergisi*, 47(1), 011-018.
85. Dinç, N., & Gökmen, MH. (2019). Atletik Performans ve Spor Genetiği. <https://doi.org/10.34087/cbusbed.529159>
86. Doğan, CS., Polat, T., Akkoç, O., Kurudirek, Mİ., & Ulucan, K. (2022). The Determination Of The Relationship Between Vo2max And The Angiotensin-Converting Enzyme Gene (ACE) rs1799752 Polymorphisms In The Turkish National Ice Hockey Sports Team. *Cellular and Molecular Biology*, 68(10), 90-93.

87. Döring, F., Onur, S., Fischer, A., Boulay, M. R., Pérusse, L., Rankinen, T., ... & Bouchard, C. (2010). A common haplotype and the Pro582Ser polymorphism of the hypoxia-inducible factor-1 α (HIF1A) gene in elite endurance athletes. *Journal of Applied Physiology*, 108(6), 1497-1500.
88. Drake, JW. Holland JJ (1999). Mutation rates among RNA viruses. *Proc Natl Acad Sci USA*, 96, 1391013913.
89. Drozdovska SB, Dosenko VE, Ahmetov II, Ilyin VN. (2013). The association of gene polymorphisms with athlete status in Ukrainians. *Biol Sport*;30:163–167.
90. Duran K., Eliöz M. (2024) Futsal ve futbolcuların SLC6A4 geni 5-HTTL-PR dağılımı. *Journal of ROL Sports Sciences* 5(1)112-124. DOI: 10.5281/zenodo.10886110
91. Duygu A. (2017). Dr. Amino asit. (1. Baskı) İstanbul Tıp Kitapevleri.
92. Eider, J., Ahmetov, I. I., Fedotovskaya, O. N., Moska, W., Cieszczyk, P., Zarebska, A., ... & Sawczuk, M. (2015). CKM gene polymorphism in Russian and Polish rowers. *Russian Journal of Genetics*, 51, 318-321.
93. Eider, J., Cieszczyk, P., Leońska-Duniec, A., Maciejewska, A., Sawczuk, M., Ficek, K., & Kotarska, K. (2013). Association of the 174 G/C polymorphism of the IL6 gene in Polish power-orientated athletes. *J Sports Med Phys Fitness*, 53(1), 88-92.
94. Eider, J., Ficek, K., Kaczmarczyk, M., Maciejewska-Karłowska, A., Sawczuk, M., & Cieszczyk, P. (2014). Endothelial nitric oxide synthase g894t (rs1799983) gene polymorphism in polish athletes. *Open Life Sciences*, 9(3), 260-267.
95. Eken, B. F., Gezmiş, H., Sercan, C., Chousen, Ö. M., Kırac, D., Akyüz, S., & Ulucan, K. (2020). D Vitamini Reseptörü ve D Vitamini Bağlayıcı Gen Polimorfizmlerinin Atletlerde DMFT İndeksi ile İlişkisi. *Gazi Beden Eğitimi ve Spor Bilimleri Dergisi*, 25(3), 177-186.
96. Eken, B. F., Şahin, Z. N., Llewellyn-waters, K., Tuna, G., Saç, A., Oktay, Ş., & Ulucan, K. (2023). Investigation of Vitamin D Receptor Gene rs731236 Polymorphism in Turkish Rugby Players. *Eurasian Research in Sport Science*, 8(1), 33-40.
97. Eken, BF, Gezmiş, H., Sercan, C., Kapıcı, S., Chousein, Ö. M., Kırac, D., ... & Ulucan, K. (2018). Türk Atletlerde D Vitamini Reseptör Geni Fok1 (rs2228570) ve Bsm1 (rs1544410) Polimorfizmlerinin Analizi. *İstanbul Gelişim Üniversitesi Sağlık Bilimleri Dergisi*, (6), 561-572.
98. Ellis, J M., Bowman, C., & Wolfgang, M J. (2015, March 11). Metabolic and Tissue-Specific Regulation of Acyl-CoA Metabolism. *PloS one*, 10(3), e0116587-e0116587. <https://doi.org/10.1371/journal.pone.0116587>
99. Erkan, E., Eken, BF, Kazancı, D., Polat, T., Yılmaz, ÖÖ., Doğan, CS., ... & Ulucan, K. (2022). Türk Uzun ve Kısa Mesafe Koşucularında Anjiyotensinojen Geni (Rs699) Polimorfizminin Atletik Performans Üzerine Etkisi. *Eurasian Research in Sport Science*, 7(1), 1-8.

100. Erlich, AT., Tryon, LD., Crilly, MJ., Memme, JM., Moosavi, ZSM., Oliveira, AN., & Hood, DA. (2016). Function of specialized regulatory proteins and signaling pathways in exercise-induced muscle mitochondrial biogenesis. *Integrative medicine research*, 5(3), 187-197.
101. Eynon N, Nasibulina ES, Banting LK, Cieszczyk P, Maciejewska-Karłowska A, Sawczuk M, Bondareva EA, Shagimardanova RR, Raz M, Sharon Y, Williams AG, Ahmetov II, Lucia A, Birk R. (2013). The FTO A/T polymorphism and elite athletic performance: a study involving three groups of European athletes. *PLoS One* ;8:e60570.
102. Eynon, N., Hanson, E D., Lucia, A., Houweling, P J., Garton, F., North, K., & Bishop, D. (2013). Genes for Elite Power and Sprint Performance: ACTN3 Leads the Way. *Sports medicine*, 43(9), 803-817. <https://doi.org/10.1007/s40279-013-0059-4>
103. Eynon, N., Meckel, Y., Alves, AJ., Nemet, D., & Eliakim, A. (2011). Is there an interaction between BDKRB2- 9/+ 9 and GNB3 C825T polymorphisms and elite athletic performance?. *Scandinavian Journal of Medicine & Science in Sports*, 21(6), e242-e246.
104. Eynon, N., Meckel, Y., Sagiv, M., Yamin, C., Amir, R., Sagiv, M., ... & Oliveira, J. (2010). Do PPARGC1A and PPARα polymorphisms influence sprint or endurance phenotypes?. *Scandinavian journal of medicine & science in sports*, 20(1), e145-e150.
105. Eynon, N., Oliveira, J., Meckel, Y., Sagiv, M., Chen, Y., Sagiv, M., Amir, R., & Duarte, J A. (2009, February 13). The guanine nucleotide binding protein β polypeptide 3 gene C825T polymorphism is associated with elite endurance athletes. *Experimental physiology*, 94(3), 344-349. <https://doi.org/10.1113/expphysiol.2008.045138>.
106. Eynon, N., Ruiz, J. R., Bishop, D. J., Santiago, C., Gómez-Gallego, F., Lucia, A., & Birk, R. (2013). The rs12594956 polymorphism in the NRF-2 gene is associated with top-level Spanish athlete's performance status. *Journal of Science and Medicine in Sport*, 16(2), 135-139.
107. Eynon, N., Ruiz, J. R., Meckel, Y., Santiago, C., Fiuza-Luces, C., Gómez-Gallego, F., & Lucia, A. (2011). Is the- 174 C/G polymorphism of the IL6 gene associated with elite power performance? A replication study with two different Caucasian cohorts. *Experimental physiology*, 96(2), 156-162.
108. Eynon, N., Ruiz, J. R., Oliveira, J., Duarte, J. A., Birk, R., & Lucia, A. (2011). Genes and elite athletes: a roadmap for future research. *The Journal of physiology*, 589(13), 3063-3070.
109. Eynon, N., Sagiv, M., Meckel, Y., Duarte, J. A., Alves, A. J., Yamin, C., & Oliveira, J. (2009). NRF2 intron 3 A/G polymorphism is associated with endurance athletes' status. *Journal of Applied Physiology*, 107(1), 76-79.

110. Fancher, RE. (2009). Scientific cousins: the relationship between Charles Darwin and Francis Galton. *American Psychologist*, 64(2), 84.
111. Faruque, MU., Millis, RM., Dunston, GM., Kwagyan, J., Bond, V., Rotimi, CN., ... & Campbell, AL. (2009). Association of GNB3 C825T polymorphism with peak oxygen consumption. *International journal of sports medicine*, 30(05), 315-319.
112. Fedotovskaya O, Eider J, Ciężczyk P, Ahmetov II., Waldemar M. Et al.(2013). Association of muscle-specific creatine kinase (CKM) gene polymorphism with combat athlete status in Polish and Russian cohorts. *Arch Budo*, 3: 233-237
113. Fedotovskaya, ON., Popov, DV., Vinogradova, OL., & Akhmetov, II. (2012). Association of muscle- specific creatine kinase (CKMM) gene polymorphism with physical performance of athletes. *Human Physiology*, 38, 89-93.
114. Ferguson L. (2006). Nutrigenomics. Integrating genomic approaches into nutrition research. *Mol Diag Ther*; 10: 101-108.
115. Fernstrom, J. D. (2012). "Role of precursor availability in the regulation of neurotransmitter synthesis." *Frontiers in Neuroenergetics*.
116. Gabbasov, RT., Arkhipova, AA., Borisova, AV., Hakimullina, AM., Kuznetsova, AV., Williams, AG., ... & Ahmetov, II. (2013). The HIF1A gene Pro582Ser polymorphism in Russian strength athletes. *The Journal of Strength & Conditioning Research*, 27(8), 2055-2058.
117. Gan-Or, Z., & Dion, P A. (2015). Genetic perspective on the role of the autophagy-lysosome pathway in Parkinson disease. <https://doi.org/10.1080/15548627.2015.1067364>
118. Genetics, Mutagenesis. (2022). <https://www.ncbi.nlm.nih.gov/books/NBK560519/>
119. Gibbs, RA. (2020). The Human Genome Project changed everything. <https://www.nature.com/articles/s41576-020-0275-3>
120. Ginevičienė, V., Jakaitienė, A., Pranculis, A., Milašius, K., Tubelis, L., & Utkus, A. (2014). AMPD1 rs17602729 is associated with physical performance of sprint and power in elite Lithuanian athletes. *BMC genetics*, 15, 1-9.
121. Gineviciene, V., Jakaitiene, A., Tubelis, L., & Kucinskas, V. (2014). Variation in the ACE, PPARGC1A and PPARA genes in Lithuanian football players. *European journal of sport science*, 14(sup1), S289- S295.
122. Ginevičienė, V., Pranculis, A., Jakaitienė, A., Milašius, K., & Kučinskas, V. (2011). Genetic variation of the human ACE and ACTN3 genes and their association with functional muscle properties in Lithuanian elite athletes. *Medicina*, 47(5), 40.
123. Ginevičienė, V., Utkus, A., Pranckevičienė, E., Semenova, E A., Hall, E., & Ahmetov, II. (2022, January

- 27). Perspectives in Sports Genomics. <https://doi.org/10.3390/biomedicines10020298>
124. Gómez-Gallego, F., Ruiz, J. R., Buxens, A., Artieda, M., Arteta, D., Santiago, C., ... & Lucia, A. (2009). The- 786 T/C polymorphism of the NOS3 gene is associated with elite performance in power sports. *European Journal of Applied Physiology*, 107, 565-569.
125. Görsel 2. Pereira, R. D., Biroli, P., Galama, T., von Hinke, S., van Kippersluis, H., Rietveld, C. A., & Thom, K. (2022). Gene-environment interplay in the social sciences. arXiv preprint arXiv:2203.02198.
126. Gözler, İ., Kavas, N., Polat, T., Doğan, C., Gözler, T., Aslan, B., & Uluçan, K. (2021). Kadın voleybolcularda hif1a (rs11549465) polimorfizm dağılımlarının incelenmesi. *RISS*, 11(1), 14-18.
127. Gregorio, I., Mereu, M., Contarini, G., Bello, L., Semplicini, C., Burgio, F., ... & Cescon, M. (2022). Collagen VI deficiency causes behavioral abnormalities and cortical dopaminergic dysfunction. *Disease Models & Mechanisms*, 15(9), dmm049481.
128. Grygiel-Górniak B. (2014). Peroxisome proliferator-activated receptors and their ligands: nutritional and clinical implications--a review. *Nutrition journal*, 13, 17. [https://doi.org/ 10.1186/1475-2891-13-17](https://doi.org/10.1186/1475-2891-13-17)
129. Guilherme, J. P. L., Souza-Junior, T. P., & Lancha Junior, A. H. (2021). Association study of performance-related polymorphisms in Brazilian combat-sport athletes highlights variants in the GABPB1 gene. *Physiological Genomics*, 53(2), 47-50.
130. Guilherme, J. P., Bosnyák, E., Semenova, E., Szmodis, M., Griff, A., Móra, Á., ... & Junior, A. L. (2021). The MCT1 gene Glu490Asp polymorphism (rs1049434) is associated with endurance athlete status, lower blood lactate accumulation and higher maximum oxygen uptake. *Biology of sport*, 38(3), 465-474.
131. Günay, M., Ülküer, MK., Çelenk, C., Bezci, S., Gökdemir, K., Gevat, C., & Kesici, T. (2010). Angiotensin-converting enzyme polymorphism in elite taekwondo athletes of Turkish and Azerbaijan taekwondo teams. *Ovidius University Annals, Series Physical Education and Sport/Science, Movement and Health*, 10(2), 165-169.
132. Günel, T., Gümüşoğlu, E., Hosseini, M. K., Yilmazyıldırım, E., Dolekcap, I., & Aydın, K. (2014). Effect of angiotensin I-converting enzyme and α -actinin-3 gene polymorphisms on sport performance. *Molecular medicine reports*, 9(4), 1422-1426.
133. Gureev, AP., Shaforostova, EA., & Попов, BH. (2019). Regulation of Mitochondrial Biogenesis as a Way for Active Longevity: Interaction Between the Nrf2 and PGC-1 α Signaling Pathways. *Frontiers in genetics*, 10. <https://doi.org/10.3389/fgene.2019.00435>
134. Guth, LM., & Roth, SM. (2013). Genetic influence on athletic performance. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3993978/>

135. Hager, NA., McAtee, CK., Lesko, MA., & O'Donnell, A. F. (2022). Inwardly rectifying potassium channel Kir2. 1 and its "Kir-ious" regulation by protein trafficking and roles in development and disease. *Frontiers in Cell and Developmental Biology*, 9, 796136.
136. Halestrap, AP. (2013). The SLC16 gene family–structure, role and regulation in health and disease. *Molecular aspects of medicine*, 34(2-3), 337-349.
137. Harmon, GS., Lam, MT., & Glass, CK. (2011). PPARs and lipid ligands in inflammation and metabolism. *Chemical reviews*, 111(10), 6321-6340.
138. Haslacher, H., Michlmayr, M., Batmyagmar, D., Perkmann, T., Ponocny-Seliger, E., Scheichenberger, V., & Winker, R. (2015). Physical exercise counteracts genetic susceptibility to depression. *Neuropsychobiology*, 71(3), 168-175.
139. Healy B. Food with a purpose (nutrigenomics). *US News World Report* 2006, 140: 60.
140. Helliwell, CA., Chin-Atkins, AN., Wilson, IW., Chapple, R., Dennis, ES., & Chaudhury, A. (2001). The Arabidopsis AMP1 gene encodes a putative glutamate carboxypeptidase. *The Plant cell*, 13(9), 2115–2125. <https://doi.org/10.1105/tpc.010146>
141. Herder Lexikon der Biologie, 2004: Mutation
142. Hesketh, J., Wybranska, I., Dommels, Y., King, M., Elliott, R., Pico, C., & Keijer, J. (2006). Nutrient– gene interactions in benefit–risk analysis. *British journal of nutrition*, 95(6), 1232-1236.
143. Holden, H. M., Rayment, I., & Thoden, J. B. (2003). Structure and function of enzymes of the Leloir pathway for galactose metabolism. *Journal of Biological Chemistry*, 278(45), 43885-43888.
144. Hood, L., & Rowen, L. (2013, January 1). The human genome project: big science transforms biology and medicine. <https://doi.org/10.1186/gm483>
145. Horiguchi, T., Miyatake, Y., Miyoshi, K., Tanimura, A., Hagita, H., Sakaue, H., & Noma, T. (2020). Gene-expression profile reveals the genetic and acquired phenotypes of hyperactive mutant Sports rat. *The Journal of Medical Investigation*, 67(1.2), 51-61.
146. Horozoglu, C., Aslan, H. E., Karaagac, A., Kucukhuseyin, O., Bilgic, T., Himmetoglu, S., ... & Zeybek, U. (2022). Effects of genetic variations of MLCK2, AMPD1, and COL5A1 on muscle endurance. *Revista Brasileira de Medicina do Esporte*, 28(4), 261-266.
147. <https://en.wikipedia.org/wiki/KCNJ15>
148. <https://en.wikipedia.org/wiki/PPP2R1A>
149. https://tr.wikipedia.org/wiki/Gen_ifadesi
150. <https://www.genome.gov/human-genome-project/What>
151. Huang, Y., Li, G., Lan, H., Zhao, G., & Huang, C. (2014). Angiotensin-converting enzyme insertion/deletion gene polymorphisms and risk of intracerebral hemorrhage: A meta-analysis of epidemiologic studies. *Journal of the Renin-Angiotensin-Aldosterone System*, 15(1), 32-38).

152. Intellectual Property in Genomics. (2019). <https://www.genome.gov/about-genomics/policy-issues/Intellectual-Property>
153. Introduction to genetics. (2006). https://en.wikipedia.org/wiki/Introduction_to_genetics
154. Itaka, T., Agemizu, K., Aruga, S., & Machida, S. (2016). G allele of the IGF2 ApaI polymorphism is associated with judo status. *Journal of strength and conditioning research*, 30(7), 2043-2048.
155. Jacob, Y., Chivers, P., & Anderton, RS. (2019). Genetic predictors of match performance in sub- elite Australian football players: A pilot study. *Journal of Exercise Science & Fitness*, 17(2), 41-46.
156. Jacob, Y., Spiteri, T., Hart, NH., & Anderton, RS. (2018). The potential role of genetic markers in talent identification and athlete assessment in elite sport. *Sports*, 6(3), 88.
157. Johnston, M. (2024, January). Genetics. AccessScience. Retrieved July 8, 2024, from <https://doi.org/10.1036/1097-8542.285300>. <https://www.accessscience.com/content/article/a285300>
158. Kadereit, J. W., Körner, C., Kost, B., & Sonnewald, U. (2014). Strasburger– Lehrbuch der Pflanzenwissenschaften. Springer-Verlag.
159. Kaman, T., Kapıcı, S., Serca, C., Konuk, M., & Ulucan, K. (2017). Türk Milli Bisikletçilerde 11. Alfa- Aktinin-3 R577X Polimorfizm Dağılımının Belirlenmesi. *Marmara Üniversitesi Spor Bilimleri Dergisi*, 2(1), 41-47.
160. Kambouris, M., Ntalouka, F., Ziogas, G., & Maffulli, N. (2012). Predictive genomics DNA profiling for athletic performance. *Recent Patents on DNA & Gene Sequences (Discontinued)*, 6(3), 229-239.
161. Kasap M. (2022). *Genç Basketbolcularda Atletik Performansın Bilişsel Süreç ile Genetik Çeşitlilik İlişkisinin İncelenmesi* [Yayımlanmamış Doktora Tezi] Bursa Uludağ üniversitesi, Eğitim Bilimleri Enstitüsü.
162. Kasap, M., & Tutkun, E. (2020). Türkiye'deki Atletik Performans- Genetik Çalışmaları; 2010-2019. *Beden Eğitimi Ve Spor Bilimleri Dergisi*, 22(1), 31-43.
163. Kawell GPA. (2005). Emerging concepts in nutrigenomics: a preview of what is to come. *Nutr Clin Pract*; 20. 75-87.
164. Kavas, NC., Yüksel, İ., Sercan, C., Kapıcı, S., Gökhan, T. & Ulucan, K. (2018). Profesyonel Monopalet Sporcularında AlfaAktinin-3 (ACTN3) R577X (rs1815739) Polimorfizminin Dağılımı ve Boy-Kilo İlişkisi. *Eurasian Research in Sport Science*, 3(1), 26- 31.
165. Kaynar, Ö., Bilici, M. F., Sercan, C., & Ulucan, K. (2021). The Examination Of The Effects Of PPAR-A (rs4253778) On Serum Lipids In Elite Cross-Country Skiers. *Spor ve Performans Araştırmaları Dergisi*, 12(1), 72-79.
166. Ke, Q., & Costa, M. (2006). Hypoxia-inducible factor-1 (HIF-1). *Molecular pharmacology*, 70(5), 1469-1480.

167. Kersten, S. (2014). Integrated physiology and systems biology of PPAR α . *Molecular metabolism*, 3(4), 354-371. <https://doi.org/10.1016/j.molmet.2014.02.002>
168. Kikuchi, N., Fuku, N., Matsumoto, R., Matsumoto, S., Murakami, H., Miyachi, M., & Nakazato, K. (2017). The association between MCT1 T1470A polymorphism and power-oriented athletic performance. *International journal of sports medicine*, 38(01), 76-80.
169. Kikuchi, N., Nakazato, K., Min, S. K., Ueda, D., & Igawa, S. (2014). The ACTN3 R577X polymorphism is associated with muscle power in male Japanese athletes. *Journal of strength and conditioning research*, 28(7), 1783-1789. <https://doi.org/10.1519/JSC.0000000000000338>
170. Kim, H., Song, K. H., & Kim, C. H. (2014). The ACTN3 R577X variant in sprint and strength performance. *Journal of exercise nutrition & biochemistry*, 18(4), 347-353. <https://doi.org/10.5717/jenb.2014.18.4.347>
171. Kim, H., Song, K.H., & Kim, C.H. (2014). The ACTN3 R577X variant in sprint and strength performance. *Journal of exercise nutrition & biochemistry*, 18(4), 347.
172. Kistak Altan, B., İlhan Odabas, H., Hakan, M. T., & Zeybek, S. U. (2024). The Relationship of Blood Lactate Level and Swimming Performance with MCT1 after Critical Velocity. *Annals of Applied Sport Science*, 0-0.
173. Knippers, R., Philippsen, P., Schäfer, K. P., & Fanning, E. (1997). Transkription, Translation und der genetische Code. *Molekulare Genetik*. Georg Thieme Verlag, Stuttgart, 45-80.
174. Kool, MJ., Onori, MP., Borgesius, NZ., van de Bree, JE., Elgersma-Hooisma, M., Nio, E., & van Woerden, G. M. (2019). CAMK2-dependent signaling in neurons is essential for survival. *Journal of Neuroscience*, 39(28), 5424-5439.
175. Krebs, HA. (1972). "The regulation of amino acid metabolism." *Biochemical Journal*.
176. Kurtuluş, M., Günay, M., Çetin, E., Çelenk, Ç., Cicioğlu, İ., Ebru, A... & Kesici, T. (2018). Elit Türk Sporcularında Anjiyotensin Dönüştürücü Enzim (I/D) Polimorfizmi ile Sportif Performans Arasındaki İlişkinin İncelenmesi. *Gaziantep Üniversitesi Spor Bilimleri Dergisi*, 3(4), 122-137.
177. Kussmann M, Raymond F, Affolter M. OMICS- dirven biomarker discovery in nutrition and health. *J Biotechnol* 2006; 124: 758-787.
178. La Montagna, R., Canonico, R., Alfano, L., Bucci, E., Boffo, S., Staiano, L., & Giordano, A. (2020). Genomic analysis reveals association of specific SNPs with athletic performance and susceptibility to injuries in professional soccer players. *Journal of cellular physiology*, 235(3), 2139-2148.
179. Larsen, D. (2016). Mutation Effects. [https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_Introductory_Biology_\(CK-12\)/04%3A_Molecular_Biology/4.10%3A_Mutation_Effects](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_Introductory_Biology_(CK-12)/04%3A_Molecular_Biology/4.10%3A_Mutation_Effects)
180. Lee, J., Bae, S., Jeong, J., Kim, S., & Kim, K. (2004, February 1). Hypoxia-inducible factor (HIF-1) α : its protein stability and biological functions. <https://doi.org/10.1038/emm.2004.1>

181. Lee, U. S., & Cui, J. (2010). BK channel activation: structural and functional insights. *Trends in neurosciences*, 33(9), 415–423. <https://doi.org/10.1016/j.tins.2010.06.004>
182. Li, C. Q., Luo, YW., Bi, FE., Cui, TT., Song, L., Cao, WY., & Dai, RP. (2014). Development of anxiety- like behavior via hippocampal IGF-2 signaling in the offspring of parental morphine exposure: effect of enriched environment. *Neuropsychopharmacology*, 39(12), 2777–2787.
183. Li, J., & Liu, Y. P. (2018). The roles of PPARs in human diseases. *Nucleosides, Nucleotides & Nucleic Acids*, 37(7), 361–382. <https://doi.org/10.1080/15257770.2018.1475673>
184. Li, J., Bench, AJ., Piltz, S., Vassiliou, G., Baxter, EJ., Ferguson-Smith, AC., & Green, AR. (2005). L3mbtl, the mouse orthologue of the imprinted L3MBTL, displays a complex pattern of alternative splicing and escapes genomic imprinting. *Genomics*, 86(4), 489–494.
185. Li, X., Wang, S. J., Tan, S. C., Chew, P. L., Liu, L., Wang, L., ... & Ma, L. (2014). The A55T and K153R polymorphisms of MSTN gene are associated with the strength training-induced muscle hypertrophy among Han Chinese men. *Journal of sports sciences*, 32(9), 883–891.
186. Li, Y., Zhu, X., Zeng, Y., Wang, J., Zhang, X., Ding, Y., & Liang, L. (2010). FMNL2 Enhances Invasion of Colorectal Carcinoma by Inducing Epithelial-Mesenchymal Transition. <https://doi.org/10.1158/1541-7786.mcr-10-0081>
187. Lin, X., Eaton, CB., Manson, JE., & Liu, S. (2017). The Genetics of Physical Activity. *Current cardiology reports*, 19(12). <https://doi.org/10.1007/s11886-017-0938-7>
188. Lippi, G., Favaloro, EJ., & Guidi, GC. (2008). The genetic basis of human athletic performance. Why are psychological components so often overlooked?. *Journal of physiology* (London. Print), 586(12), 3017–3017. <https://doi.org/10.1113/jphysiol.2008.155887>
189. Lippi, G., Longo, U G., & Maffulli, N. (2009). Genetics and sports. <https://doi.org/10.1093/bmb/ldp007>
190. Lippi, G., Longo, U. G., & Maffulli, N. (2010). Genetics and sports. *British medical bulletin*, 93, 27 – 47. <https://doi.org/10.1093/bmb/ldp007>
191. Liu, L., Zhang J., Yuan, J., Dang, Y., Yang, C., Chen, X., & Yu, L. (2005). Characterization of a human regulatory subunit of protein phosphatase 3 gene (PPP3RL) expressed specifically in testis. *Molecular biology reports*, 32, 41–45.
192. López-Léon, S., Tuvblad, C., & Forero, D A. (2016). Sports genetics: the PPARA gene and athletes' high ability in endurance sports. A systematic review and meta-analysis.. *DOAJ* (DOAJ: Directory of Open Access Journals), 33(1), 3–6. <https://doi.org/10.5604/20831862.1180170>
193. Loro, E., Seifert, E. L., Moffat, C., Romero, F., Mishra, M. K., Sun, Z., Krajacic, P., Anokye-Danso, F., Summer, R. S., Ahima, R. S., & Khurana, T. S. (2015). IL-15Ra is a determinant of muscle fuel utilization, and its

- loss protects against obesity. *American journal of physiology. Regulatory, integrative and comparative physiology*, 309(8), R835–R844. <https://doi.org/10.1152/ajpregu.00505.2014>
194. Lozzi, B., Huang, T., Sardar, D., Huang, A Y., & Deneen, B. (2020). Regionally Distinct Astrocytes Display Unique Transcription Factor Profiles in the Adult Brain. <https://doi.org/10.3389/fnins.2020.00061>
 195. MacGrogan, D., Kalakonda, N., Alvarez, S., Scandura, J. M., Bocconi, P., Johansson, B., & Nimer, S.D. (2004). Structural integrity and expression of the L3MBTL gene in normal and malignant hematopoietic cells. *Genes, Chromosomes and Cancer*, 41(3), 203-213.,
 196. Maciejewska-Skrendo, A., Cięższyk, P., Chycki, J., Sawczuk, M., & Smółka, W. (2019). Genetic markers associated with power athlete status. *Journal of human kinetics*, 68(1), 17-36.
 197. Maruszak, A., Adamczyk, JG., Siewierski, M., Sozański, H., Gajewski, A., & Żekawowski, C. (2014). Mitochondrial DNA variation is associated with elite athletic status in the Polish population. *Scandinavian journal of medicine & science in sports*, 24(2), 311-318.
 198. Massidda, M., Calò, C M., Cięższyk, P., Kikuchi, N., Ahmetov, I I., & Williams, A G. (2019). Genetics of team sports. <https://doi.org/10.1016/b978-0-12-816193-7.00005-1>
 199. Massidda, M., Mendez-Villanueva, A., Ginevičienė, V., Proia, P., Drozdovska, S. B., Dosenko, V., & Calò, C. M. (2018). Association of Monocarboxylate Transporter-1 (MCT1) A1470T Polymorphism (rs1049434) with Forward Football Player Status. *International journal of sports medicine*, 39(13), 1028-1034.
 200. Mc Fie, S., Abrahams, S., Patricios, J., Suter, J., Posthumus, M., & September, A. V. (2018). The association between COMT rs4680 and 5-HTTLPR genotypes and concussion history in South African rugby union players. *Journal of sports sciences*, 36(8), 920-933.
 201. McAuley, AB., Hughes, DC., Tsaprouni, LG., Varley, I., Suraci, B., Roos, TR., ... & Kelly, AL. (2021). Genetic association research in football: A systematic review. *European journal of sport science*, 21(5), 714-752.
 202. Miller, DD., & Williams, KD. (2012). "The Role of GABA in the Regulation of Emotion." *The Scientific World Journal*.
 203. Misteli, T., & Soutoglou, E. (2009). The emerging role of nuclear architecture in DNA repair and genome maintenance. *Nature Portfolio*, 10(4), 243-254.<https://doi.org/10.1038/nrm2651>
 204. Moir, HJ., Kemp, R., Folkerts, D., Spendiff, O., Pavlidis, C., & Opara, E. (2019). Genes and elite marathon running performance: a systematic review. *Journal of sports science & medicine*, 18(3), 559.
 205. Moore, GE., Shuldiner, AR., Zmuda, JM., Ferrell, RE., McCole, SD., & Hagberg, JM. (2001). Obesity gene variant and elite endurance performance. *Metabolism-Clinical and Experimental*, 50(12), 1391-1392.

206. Muhan, A., Polat, T., Yılmaz, ÖÖ., Aslan, BT., & Ulucan, K. (2023). Futbolcularda ACTN3 rs1815739 Polimorfizmi, Fiziksel Özellikler ve Mevki İlişkinin Araştırılması: Bir Takım Örneklemi. *Research in Sport Education and Sciences*, 25(1), 14-18.
207. Müller, DJ., & Bärtsch, P. (2013). "Branched-Chain Amino Acids and Metabolic Regulation." *Nutrients*.
208. Mustafina LJ, Naumov VA, Cieszczyk P, Popov DV, Lyubaeva EV, ... (2014). AGTR2 gene polymorphism is associated with muscle fibre composition, athletic status and aerobic performance. *Exp Physiol*, 99:1042-1052.
209. Mutlucan, H., Bıyıklı, T., Eken, BF., Sercan, C., Kapıcı, S., & Ulucan, K. (2017). Türk Profesyonel Futbolcularda Alfa-Aktinin3N R577 X Polimorfizminin İncelenmesi. *Marmara Üniversitesi Spor Bilimleri Dergisi*, 2(2), 1-7.
210. Naureen, Z., Perrone, M., Paolacci, S., Maltese, PE., Dhuli, K., Kurti, D., & Bertelli, M. (2020). Genetic test for the personalization of sport training. *Acta Bio Medica: Atenei Parmensis*, 91(Suppl 13).
211. Nugent AP. Nutrigenomics. Tailor-made foods for a genetic era? *Nutr Bull* 2004; 29: 82-83.
212. O'Connell K, Posthumus M, Collins M. (2011). COL6A1 gene and Ironman triathlon performance. *Int J Sports Med*;32:896-901.
213. Oliveira-Paula, GH., Lacchini, R., & Tanus-Santos, JE. (2016). Endothelial nitric oxide synthase: From biochemistry and gene structure to clinical implications of NOS3 polymorphisms. *Gene*, 575(2), 584-599.
214. Onali, F., Calò, CM., Massidda, M., Álvarez-Álvarez, MM., & Esteban, ME. (2018). An unexpected world population variation of MCT1 polymorphism 1470T> A involved in lactate transport. *European journal of sport science*, 18(10), 1376-1382.
215. Ordovas JM, Corella D. (2004). Nutritional genomics. *Annu Rev Genomics Hum Genet*, 5: 71-118.
216. Orysiak, J., Busko, K., Michalski, R., Mazur-Różycka, J., Gajewski, J., Malczewska-Lenczowska, J., & Pokrywka, A. (2014). Relationship between ACTN3 R577X polymorphism and maximal power output in elite Polish athletes. *Medicina*, 50(5), 303-308.
217. Oshidari, R., Strecker, J., Chung, DKC., Abraham, K J., Chan, J N., Damaren, C J., & Mekhail, K. (2018). Nuclear microtubule filaments mediate non-linear directional motion of chromatin and promote DNA repair. *Nature Portfolio*, 9(1). <https://doi.org/10.1038/s41467-018-05009-7>
218. Ostrander, E A., Huson, H J., & Ostrander, G K. (2009, September 1). Genetics of Athletic Performance. *Annual review of genomics and human genetics* (Print), 10(1), 407-429. <https://doi.org/10.1146/annurev-genom-082908-150058>

219. Palomer, X., Barroso, E., Pizarro-Delgado, J., Peña, L., Botteri, G., ... (2018). PPAR β/δ : A Key Therapeutic Target in Metabolic Disorders. *International journal of molecular sciences*, 19(3), 913- 913. <https://doi.org/10.3390/ijms19030913>
220. Panneerselvam, S., Wang, J., Zhu, W., Dai, H., Pappas, J. G., Rabin, R., ... & Bi, W. (2021). PPP3CA truncating variants clustered in the regulatory domain cause early-onset refractory epilepsy. *Clinical genetics*, 100(2), 227-233.
221. Peng, Y., Cui, C., He, Y., Ouzhuluobu, O., Zhang, H.,(2017). Down-Regulation ofEPAS1Transcription and Genetic Adaptation of Tibetans to High-Altitude Hypoxia. *Molecular biology and evolution*, msw280-msw280. <https://doi.org/10.1093/molbev/msw280>
222. Petr, M.,Maciejewska-Skrendo,A.,Zajac, A.,Chycki,J., & Štastný, P. (2019). Association of Elite Sports Status with Gene Variants of Peroxisome Proliferator Activated Receptors and Their Transcriptional Coactivator. *International journal of molecular sciences*, 21(1), 162-162. <https://doi.org/10.3390/ijms21010162>
223. Posthumus, M., September, AV., O’Cuinneagain, D., van der Merwe, W., Schwellnus, MP, & Collins, M. (2009). The COL5A1 gene is associated with increased risk of anterior cruciate ligament ruptures in female participants. *The American journal of sports medicine*, 37(11), 2234-2240.
224. Potera C. (2004). Diet and DNA. *Environ Health Persp* ; 112: A404.
225. Pratt, J., Boreham, C., Ennis, S., Ryan, A W., & Vito, G D. (2019). Genetic Associations with Aging Muscle: A Systematic Review. <https://doi.org/10.3390/cells9010012>
226. Proia, P., Bianco, A., Schiera, G., Saladino, P., Contrò, V., Caramazza, G., & Paoli, A. (2014). PPAR α gene variants as predicted performance-enhancing polymorphisms in professional Italian soccer players. *Open access journal of sports medicine*, 273-278.
227. Quinn,LS.,Haugk, K., & Grabstein, KH. (1995). Interleukin-15: a novel anabolic cytokine for skeletal muscle.*Endocrinology*,136(8),3669-3672. <https://doi.org/10.1210/endo.136.8.7628408>
228. Regué, L., Minichiello, L., Avruch, J., & Dai, N. (2019). Liver-specific deletion of IGF2 mRNA binding protein-2/IMP2 reduces hepatic fatty acid oxidation and increases hepatic triglyceride accumulation. *The Journal of biological chemistry*, 294(31), 11944–11951. <https://doi.org/10.1074/jbc.RA119.008778>
229. Riabovol, O O., Tsymbal, D O., Minchenko, D O., Lebid-Biletska, K M., Sliusar, M Y., Rudnytska, O V., & Minchenko, O H. (2019). Effect of glucose deprivation on the expression of genes encoding glucocorticoid receptor and some related factors in ERN1-knockdown U87 glioma cells. <https://doi.org/10.2478/enr-2019-0024>

230. Ricanek, P., Lunde, L K., Frye, S A., Støen, M., Nygård, S., Morth, J P., Rydning, A., Vatn, M H., Amiriy- Moghaddam, M., & Tønjum, T. (2015). Reduced expression of aquaporins in human intestinal mucosa in early stage inflammatory bowel disease. <https://doi.org/10.2147/ceg.s70119>
231. Riis-Vestergaard, MJ., Richelsen, B., Bruun, JM., Li, W., Hansen, JB., & Pedersen, SB. (2020). Beta-1 and not beta-3 adrenergic receptors may be the primary regulator of human brown adipocyte metabolism. *The Journal of Clinical Endocrinology & Metabolism*, 105(4), e994-e1005.
232. Rozec, B., & Gauthier, C. (2006). β 3-Adrenoceptors in the cardiovascular system: putative roles in human pathologies. *Pharmacology & therapeutics*, 111(3), 652-673.
233. Ruiz, JR., Buxens, A., Artieda, M., Arteta, D., Santiago, C., Rodríguez-Romo, G., & Lucia, A. (2010). The-174 G/C polymorphism of the IL6 gene is associated with elite power performance. *Journal of science and medicine in sport*, 13(5), 549-553.
234. Şahin, K., Bozkurt, N., Şavkın, S., Bülbül, A., İpekoğlu, G., & Çakır, H. İ. (2023). Investigation of COL12A1 Gene Polymorphism Profile in Genetic Injury Susceptibility in Football Players Having Anterior Cruciate Ligament Surgery.
235. Sanhueza, J., Zambrano, T., Bahamondes-Ávila, C., & Salazar, L A. (2016). Association of Anxiety- Related Polymorphisms with Sports Performance in Chilean Long Distance Triathletes: A Pilot Study.. *PubMed*, 15(4), 554-561. <https://pubmed.ncbi.nlm.nih.gov/27928199/>
236. Şanlısoy, F., Altıntaş, N., Büyükyazı, G., & Candan, N. (2011). Ege bölgesi elit sporcularının ACTN3 R577X genotip dağılımının araştırılması. *Cumhuriyet Medical Journal*, 33(2), 153-159.
237. Santos, C G M D., Pimentel-Coelho, P M., Budowle, B., Moura-Neto, R., Dornelas-Ribeiro, M., Pompeu, F., & Silva, R. (2015). The heritable path of human physical performance: from single polymorphisms to the “next generation”. <https://doi.org/10.1111/sms.12503>
238. Sarmiento,H.,Marques, A., Field, A., Martins, J., Gouveia, É., Mondragón, L. P., & Clemente, F. (2020). Genetic influence on football performance-a systematic review. *Human Movement*, 21(4), 1-17.
239. Sarpeshkar, V., & Bentley, D. J. (2010). Adrenergic- β 2 receptor polymorphism and athletic performance. *Journal of human genetics*, 55(8), 479-485.
240. Sarpeshkar,V., & Bentley, DJ. (2010). Adrenergic- β 2 receptor polymorphism and athletic perfor- mance. *Journal of human genetics*, 55(8), 479-485.
241. Saunders,CJ., Xenophontos, SL., Cariolou, MA., Anastassiades, LC.,-Noakes, TD., & Collins, M. (2006). The bradykinin β 2 receptor (BD-KRB2) and endothelial nitric oxide synthase 3 (NOS3) genes and endurance performance during Ironman Triathlons. *Human molecular genetics*, 15(6), 979-987.

242. Sawczuk, M., Banting, LK., Cięższyk, P., Maciejewska-Karłowska, A., Zarębska, A., Leońska-Duniec, A., ... & Eynon, N. (2015). MCT1 A1470T: a novel polymorphism for sprint performance?. *Journal of science and medicine in sport*, 18(1), 114-118.
243. Sawczuk, M., Maciejewska-Karłowska, A., Cięższyk, P., & Leońska-Duniec, A. (2014). Is Gnb3 C825t Polymorphism Associated With Elite Status Of Polish Athletes?. *Biology of Sport*, 31(1), 21-25.
244. Sawczuk, M., Maciejewska-Karłowska, A., Cięższyk, P., Skotarczak, B., & Ficek, K. (2013). Association of the ADRB2 Gly16Arg and Glu27Gln polymorphisms with athlete status. *Journal of Sports Sciences*, 31(14), 1535–1544. <https://doi.org/10.1080/02640414.2013.786184>
245. Sawyer, SA., Parsch, J., Zhang, Z., & Hartl, DL. (2007). Prevalence of positive selection among nearly neutral amino acid replacements in *Drosophila*. *Proceedings of the National Academy of Sciences*, 104(16), 6504-6510.
246. Schinka,JA., Letsch,EA., & Crawford,FC.(2002). DRD4 and novelty seeking: Results of metaanalyses. *American journal of medical genetics*, 114(6), 643-648.
247. Schumacker,PT. (2005, December 5). Hypoxia-inducible factor-1 (HIF-1). <https://journals.lww.com/00003246-200512001-00009>
248. Semenova, EA., Hall, EC., & Ahmetov,II. (2023). Genes and athletic performance: the 2023 update. *Genes*, 14(6), 1235.
249. Senarath, K., Kankanamge, D., Samaradivakara, S., Ratnayake, K., Tennakoon, M., & Karunaratne, A. (2018). Regulation of G Protein $\beta\gamma$ Signaling. <https://doi.org/10.1016/bs.ircmb.2018.02.008>
250. Shahmoradi, S., Ahmadalipour, A., & Salehi, M. (2014). Evaluation of ACE gene I/D polymorphism in Iranian elite athletes. *Advanced Biomedical Research*, 3(1), 207.
251. Shakkottai, VG., & Fogel, BL. (2013). Autosomal Dominant Spinocerebellar Ataxia. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3818725/>
252. Sharma, JN. (2016). The Role of Bradykinin System in Type 2 Diabetes. *Journal of diabetes & metabolism*, 07(03). <https://doi.org/10.4172/2155-6156.1000658>
253. Shen,XZ., Xiao,H., Li,P., Lin, C., Billet, S., Okwan-Duodu, D., Adams, JW., Bernstein, EA., Xu, Y., Fuchs, S., & Bernstein, K E. (2008). New insights into the role of angiotensin-converting enzyme obtained from the analysis of genetically modified mice. *Journal of molecular medicine (Berlin, Print)*, 86(6), 679-684. <https://doi.org/10.1007/s00109-008-0325-3>
254. Simopoulos AP. (2002). Genetic variation and dietary response: nutrigenetics/nutrigenomics. *Asia Pacific J Clin Nutr* 11: S1;17-S128.
255. Spindler, K., Horodyski, F., Grabau, E., Nichol, S., & Vandepol, S. (1982). Rapid evolution of RNA genomes. *Science*, 215(4540), 1577-1585.

256. Stępień-Słodkowska, M., Ficek, K., Kaczmarczyk, M., Maciejewska-Karłowska, A., Sawczuk, M., Leońska-Duniec, A., & Cięższyk, P. (2015). The variants within the COL5A1 gene are associated with reduced risk of anterior cruciate ligament injury in skiers. *Journal of Human Kinetics*, 45(1), 103-111.
257. Süel, E., & Pehlivan, A. (2015). Angiotension dönüştürücü (Converting) Enzim (ACE) gen polimorfizminin elit basketbolcu ve voleybolcularda karşılaştırılması. *Uluslararası Spor Egzersiz ve Antrenman Bilimi Dergisi*, 1(1), 40-50.
258. Tahara, A., Osaki, Y., & Kishimoto, T. (2010). Effect of the β 3-adrenergic receptor gene polymorphism Trp64Arg on BMI reduction associated with an exercise-based intervention program in Japanese middle-aged males. *Environmental health and preventive medicine*, 15, 392-397.
259. Takeda, N., Maemura, K., Imai, Y., Harada, T., Kawanami, D., Nojiri, T., Manabe, I., & Nagai, R. (2004). Endothelial PAS Domain Protein 1 Gene Promotes Angiogenesis Through the Transactivation of Both Vascular Endothelial Growth Factor and Its Receptor, Flt-1. <https://doi.org/10.1161/01.res.0000134920.10128.b4>
260. Tan, W., Wang, Y., Gold, B., Chen, J., Dean, M., Harrison, P. J., & Law, A. J. (2007). Molecular Cloning of a Brain-specific, Developmentally Regulated Neuregulin 1 (NRG1) Isoform and Identification of a Functional Promoter Variant Associated with Schizophrenia*♦. *Journal of Biological Chemistry*, 282(33), 24343-24351.
261. Taylor, SB., Taylor, AR., & Koenig, J. I. (2013). The interaction of disrupted type II neuregulin I and chronic adolescent stress on adult anxiety-and fear-related behaviors. *Neuroscience*, 249, 31-42.
262. Tchieu, J., Calder, EL., Guttikonda, SR., Gutzwiller, E., Aromolaran, K A., Steinbeck, J A., Goldstein, P A., & Studer, L. (2019). NFIA is a gliogenic switch enabling rapid derivation of functional human astrocytes from pluripotent stem cells. *Nature biotechnology*, 37(3), 267-275. <https://doi.org/10.1038/s41587-019-0035-0>
263. Thakkar, D., Sicova, M., Guest, NS., Garcia-Bailo, B., & El-Sohemy, A. (2021). HFE genotype and endurance performance in competitive male athletes. *Medicine & Science in Sports & Exercise*, 53(7), 1385-1390.
264. The effects of mutations. (2021). <https://evolution.berkeley.edu/dna-and-mutations/the-effects-of-mutations/>
265. The GABPB1 gene A/G polymorphism in Polish rowers. (2012). <https://sciendo.com/pdf/10.2478/v10078-012-0012-x>
266. The Lancet (2018). CRISPR-Cas9: a world first? *Lancet*; 8;392(10163):2413. doi: 10.1016/S0140- 6736(18)33111-8. PMID: 30527398.
267. Thomson, CJ., Hanna, CW., Carlson, SR., & Rupert, JL. (2013). The- 521 C/T variant in the dopa- mine-4-receptor gene (DRD4) is associated with skiing and snowboarding behavior. *Scandinavian journal of medicine & science in sports*, 23(2), e108-e113.

268. Thomson, CJ, Rajala, AK., Carlson, SR., & Rupert, JL. (2014). Variants in the dopamine-4-receptor gene promoter are not associated with sensation seeking in skiers. *PloS one*, 9(4), e93521.
269. Thomson, D., Rosenich, E., Maruff, P., Lim, YY., & Alzheimer's Disease Neuroimaging Initiative. (2024). BDNF Val66Met moderates episodic memory decline and tau biomarker increases in early sporadic Alzheimer's disease. *Archives of Clinical Neuropsychology*, acae014.
270. Tian, H., McKnight, S L., & Russell, D W. (1997). Endothelial PAS domain protein 1 (EPAS1), a transcription factor selectively expressed in endothelial cells.. *Genes & development*, 11(1), 72-82. <https://doi.org/10.1101/gad.11.1.72>
271. Trujillo E, Davis C, Milner J. (2006). Nutrigenomics, proteomics, metabolomics, and the practice of dietetics. *J Am Diet Assoc*; 106: 403-413.
272. Tuna, G. (2022). Kısa ve uzun mesafe profesyonel Türk yüzücülerde ACTN3 (rs1815739), IL6 (rs1800795), COL1A1 (rs1800012) ve MCT1 (rs1049434) polimorfizmlerinin ve antropometrik ölçümlerinin atletik performans üzerine etkilerinin araştırılması.
273. Tunalı, S., Yiğit, S., Sercan, C., Polat, T., Ekmekçi, R., & Ulucan, K. (2019) Profesyonel Voleybolcularda Katekol-OMetiltransferaz (COMT) rs4680 Polimorfizminin Belirlenmesi. *Eurasian Research in Sport Science*, 4(1), 1-6.
274. Tural, E., Kara, N., Agaoglu, S. A., Elbistan, M., Tasmektepligil, M. Y., & Imamoglu, O. (2014). PPAR- α and PPARGC1A gene variants have strong effects on aerobic performance of Turkish elite endurance athletes. *Molecular biology reports*, 41(9), 5799-5804.,
275. Tural, E., Kara, N., Agaoglu, SA., Elbistan, M., Tasmektepligil, M Y., & Imamoglu, O. (2014). PPAR- α and PPARGC1A gene variants have strong effects on aerobic performance of Turkish elite endurance athletes. *Molecular biology reports*, 41, 5799-5804.
276. Tyagi, S., Gupta, P., Saini, AS., Kaushal, C., & Sharma, S. (2011). The peroxisome proliferator-activated receptor: A family of nuclear receptors role in various diseases. *Journal of advanced pharmaceutical technology and research*, 2(4), 236-236. <https://doi.org/10.4103/2231-4040.90879>
277. Ulucan K., Yalçın, S., Akbaş, B., Uyumaz, F., & Konuk, M. (2014). Analysis of Solute Carrier Family 6 Member 4 Gene promoter polymorphism in young Turkish basketball players. *J Neuro Behave Sci*. 1(2), 37-40.
278. Ulucan, K., Bayyurt, GM., Konuk, M., & Güney, AI. (2014). Effect of alpha-actinin-3 gene on trained and untrained Turkish middleschool children's sprinting performance: a pilot study. *Biological rhythm research*, 45(4), 509- 514.
279. Ulucan, K., ÇAM N., Sercan, C., Akbaş, B., Uyumaz, F., & Yalçın, S. (2015). Genç Basketbolcularda Anjiotensin Dönüştürücü Enzim (ACE I/D) ve AlfaAktinin-3 (ACTN3 R577X) Gen Polimorfizmlerinin Belirlenmesi İçin Pilot Bir Çalışma. *Spor Bilimleri Dergisi*, 26(2), 44-50.

280. Ulucan, K., Göle, S., Altindas, N., & Güney, A. I. (2013). Preliminary findings of α -actinin3 gene distribution in elite Turkish wind surfers. *Balkan journal of medical genetics*, 16(1), 69-72
281. Ulucan, K., Sercan, C., Eken, B. F., Ülgüt, D., & Erel, Ş. (2016). Spor genetiği ve ACE gen ilişkisi. İnönü Üniversitesi Beden Eğitimi ve Spor Bilimleri Dergisi, 3(2), 26-34.
282. Um, JW., Pramanik, G., Ko, JS., Song, MY., Lee, D., Kim, H., Park, KS., Südhof, TC., Tabuchi, K., & Ko, J. (2014). Calsyntenins Function as Synaptogenic Adhesion Molecules in Concert with Neurexins. *Cell reports*, 6(6), 1096-1109. <https://doi.org/10.1016/j.celrep.2014.02.010>.
283. Valeeva, EV., Ahmetov, I I., & Rees, T. (2019). Psychogenetics and sport. Elsevier eBooks, 147-165. <https://doi.org/10.1016/b978-0-12-816193-7.00007-5>
284. Van Breda, KR., Rauch, L., & Collins, M. (2015). The Comt Val158met Polymorphism And Psychological Variables: Comparison Between Ultra-endurance Athletes And Recreationally Active Controls: 177 Board# 28 May 27, 11: 00 AM-12: 30 PM. *Medicine & Science in Sports & Exercise*, 47(5S), 32.
285. Varillas-Delgado, D., Del Coso, J., Gutiérrez-Hellín, J., Aguilar-Navarro, M., Muñoz, A., Maestro, A., & Morencos, E. (2022). Genetics and sports performance: the present and future in the identification of talent for sports based on DNA testing. *European journal of applied physiology*, 122(8), 1811-1830.
286. Varillas-Delgado, D., Coso, J D., Gutiérrez-Hellín, J., Aguilar-Navarro, M., Muñoz, A., Maestro, A., & Morencos, E. (2022). Genetics and sports performance: the present and future in the identification of talent for sports based on DNA testing. *European journal of applied physiology (Print)*, 122(8), 1811-1830. <https://doi.org/10.1007/s00421-022-04945-z>.
287. Varillas-Delgado, D., Coso, J D., Gutiérrez-Hellín, J., Aguilar-Navarro, M., Muñoz, A., Maestro, A., & Morencos, E. (2022). Genetics and sports performance: the present and future in the identification of talent for sports based on DNA testing. *European journal of applied physiology*, 122(8), 1811- 1830. <https://doi.org/10.1007/s00421-022-04945-z>
288. Wang G, Padmanabhan S, Wolfarth B, Fuku N, Lucia A, Ahmetov II, Cieszyk P, Collins M, Eynon N, Klissouras V, Williams A, Pitsiladis Y. (2013). Genomics of elite sporting performance: what little we know and necessary advances. *Adv Genet*, 84:123–149.
289. Werner, H., Sarfstein, R., & Bruchim, I. (2019). Investigational IGF1R inhibitors in early stage clinical trials for cancer therapy. <https://doi.org/10.1080/13543784.2019.1694660>
290. Weyerstraß, J., Stewart, K., Wesselius, A., & Zeegers, M. (2018). Nine genetic polymorphisms associated with power athlete status—a meta-analysis. *Journal of science and medicine in sport*, 21(2), 213-220.

291. Williams, C J., Williams, M., Eynon, N., Ashton, K J., Little, J P., Wislöff, U., & Coombes, J S. (2017). Genes to predict VO₂max trainability: a systematic review. *BMC genomics*, 18(S8). <https://doi.org/10.1186/s12864-017-4192-6>
292. Willis L. Nutrients – individualized nutrition. *Experience Life Magazine* September/October 2002, Volume 4, Issue 5. http://www.lifetimefitness.com/magazine/Index.cfm?strWebAction=article_detail&intArticleI
293. Winkler, ME. (2019). Gene. *AccessScience*. Retrieved July 3, 2024, from <https://doi.org/10.1036/1097-8542.284400>.
294. Wolfarth, B., Rankinen, T., Mühlbauer, S., Scherr, J., Boulay, M. R., Pérusse, L., & Bouchard, C. (2007). Association between a β 2-adrenergic receptor polymorphism and elite endurance performance. *Metabolism*, 56(12), 1649-1651.
295. Wolfe, RR. (2002). "Branched-Chain Amino Acids in the Regulation of Protein Metabolism." *Nutrition Reviews*.
296. Wu, G. (2013). Functional amino acids in nutrition and health. *Amino acids*, 45, 407-411.
297. Wurtman, RJ., & Wurtman, JJ. (1995). "Dietary carbohydrate and brain serotonin: a theory of obesity." *The American Journal of Clinical Nutrition*.
298. www.evrimagaci.org
299. Yamaguchi, N., Winter, CM., Wu, M., Kwon, CS., William, DA., & Wagner, D. (2014). Protocol:Chromatin Immunoprecipitation from Arabidopsis Tissues.<https://doi.org/10.1199/tab.0170>
300. Yamak, B., Yuç, M., Bağcı, H., & Imamoglu, O. (2015). Association between sport performance and alpha-actinin-3 gene R577X polymorphism. *International Journal of Human Genetics*, 15(1), 13- 19.
301. Yan, Z., Okutsu, M., Akhtar, Y., & Lira, VA. (2011). Regulation of exercise-induced fiber type transformation, mitochondrial biogenesis, and angiogenesis in skeletal muscle. *Journal of applied physiology*, 110(1), 264-274. <https://doi.org/10.1152/jappphysiol.00993.2010>
302. Yang N, MacArthur DG, Gulbin JP, Hahn AG, Beggs AH, Eastale S, North K. (2003). ACTN3 genotype is associated with human elite athletic performance. *Am J Hum Genet*, 73(3):627-31.
303. Yang, L. K., & Tao, Y. X. (2019). Physiology and pathophysiology of the β 3-adrenergic receptor. *Progress in molecular biology and translational science*, 161, 91-112.
304. Yang, R., Shen, X., Wang, Y., Voisin, S., Cai, G., Fu, Y., & Yan, X. (2017). ACTN3 R577X gene variant is associated with muscle-related phenotypes in elite Chinese sprint/power athletes. *The Journal of Strength & Conditioning Research*, 31(4), 1107-1115.
305. Yigit, S., Polat, T., Dogan, C. S., Tunalı, S., Ekmekçi, R., & Ulucan, K. (2020). Profesyonel Voleybolcularda Slc6a4 Promotör L/S Polimorfizminin Belirlenmesi Ve Literatür Karşılaştı; Determination of SLC6A4 Promoter L/S Polymorphism in Professional Volleyball Players and Compar-

- ison of the Literature. *The Journal of Neurobehavioral Sciences*, 7(2), 66-71.
306. Yılmaz, ÖÖ., Polat, T., Tacal Aslan, B., Yüksel, İ., Göçücü, K., Zileli, R., & Ulucan, K. (2024). Determination of COL1A1 rs1800012 Polymorphism Related to Ligament and Tendon Injury in Turkish Professional Bodybuilders: Experimental Research. *Turkiye Klinikleri Journal of Sports Sciences*, 16(1).
307. Yu, BP. (2015). Nutrition, Exercise and Epigenetics: Ageing Interventions. <https://doi.org/10.1007/978-3-319-14830-4>
308. Yvert, T., Miyamoto-Mikami, E., Murakami, H., Miyachi, M., Kawahara, T., & Fuku, N. (2016). Lack of replication of associations between multiple genetic polymorphisms and endurance athlete status in Japanese population. *Physiological reports*, 4(20), e13003.
309. Zarebska, A., Sawczyn, S., Kaczmarczyk, M., Ficek, K., Maciejewska-Karlowska, A., Sawczuk, M., & Cieszczyk, P. (2013). Association of rs699 (M235T) polymorphism in the AGT gene with power but not endurance athlete status. *The Journal of Strength & Conditioning Research*, 27(10), 2898-2903.
310. Zhang,L., Lv,B., Shi,X., & Gao,G. (2020). High Expression of N-Acetylgalactosa-4-epimerase 1 (GALNT1) Associated with Invasion, Metastasis, and Proliferation in Osteosarcoma. *Medical science monitor*, 26. <https://doi.org/10.12659/msm.927837>.
311. Zmijewski, P., Grenda, A., Leonska-Duniec, A., Ahmetov, I., Orysiak, J., & Cieszczyk, P. (2016). Effect of BDKRB2 gene- 9/+ 9 polymorphism on training improvements in competitive swimmers. *The Journal of Strength & Conditioning Research*, 30(3), 665-671.