■ جهت مطالعه بیشتر

Barker K (2005). At the bench: a laboratory navigator, 2nd edn. Cold Spring Harbor Laboratory Press.

■ منابع

Baar K and Esser K (1999). Phosphorylation of p70(S6k) correlates with increased skeletal muscle mass following resistance exercise. Am J Physiol 276, C120–C127.

Baldwin KM (2000). Research in the exercise sciences: where do we go from here? J Appl Physiol 88, 332–336.

Barker K (2005). At the bench: a laboratory navigator, 2nd edn. Cold Spring Harbor Laboratory Press.

Booth FW (1988). Perspectives on molecular and cellular exercise physiology. J Appl Physiol 65, 1461–1471.

Bouchard C, Chagnon M, ibault MC, Boulay MR, Marcotte M, Cote C and Simoneau JA (1989). Muscle genetic variants and relationship with performance and trainability. Med Sci Sports Exerc 21, 71–77.

Bouchard C, Malina RM and Perusse L (1997). Genetics of fitness and physical performance. Human Kinetics, Champaign, IL.

Bouchard C, Sarzynski MA, Rice TK, Kraus WE, Church TS, Sung YJ, et al. (2011). Genomic predictors of the maximal O uptake response to standardized exercise training programs. J Appl Physiol 110, 1160–1170.

Campbell WG, Gordon SE, Carlson CJ, Pattison JS, Hamilton MT and Booth FW (2001). Differential global gene expression in red and white skeletal muscle. Am J Physiol Cell Physiol 280, C763–C768.

Chin ER, Olson EN, Richardson JA, Yang Q, Humphries C, Shelton JM, et al. (1998). A calcineurin-dependent transcriptional pathway controls skeletal muscle fiber type. Genes Dev 12, 2499–2509.

Collins CA and Zammit PS (2009). Isolation and grafting of single muscle fibres. Methods Mol Biol 482, 319–330.

de la Chapelle A, Traskelin AL and Juvonen E (1993). Truncated erythropoietin receptor causes dominantly inherited benign human erythrocytosis. Proc Natl Acad Sci U S A 90, 4495–4499.

Deriaz O, Dionne F, Perusse L, Tremblay A, Vohl MC, Cote G and Bouchard C (1994). DNA variation in the genes of the Na,K-adenosine triphosphatase and its relation with resting metabolic rate, respiratory quotient, and body fat. J Clin Invest 93, 838–843.

Dionne FT, Turcotte L, ibault MC, Boulay MR, Skinner JS and Bouchard C (1991). Mitochondrial DNA sequence polymorphism, V.O2max, and response to endurance training. Med Sci Sports Exerc 23, 177–185.

Garry DJ, Ordway GA, Lorenz JN, Radford NB, Chin ER, Grange RW, et al. (1998). Mice without myoglobin. Nature 395, 905–908.

Gibson DG, Benders GA, Andrews-Pfannkoch C, Denisova EA, Baden-Tillson H, Zaveri J, et al. (2008). Complete chemical synthesis, assembly, and cloning of a Mycoplasma genitalium genome. Science 319, 1215–1220.

Hamilton MT and Booth FW (2000). Skeletal muscle adaptation to exercise: a century of progress. J Appl Physiol 88, 327–331.

Hayot M, Michaud A, Koechlin C, Caron MA, Leblanc P, Prefaut C, and Maltais F (2005). Skeletal muscle microbiopsy: a validation study of a minimally invasive technique. Eur Respir J 25, 431–440.

Hood DA, Balaban A, Connor MK, Craig EE, Nishio ML, Rezvani M and Takahashi M (1994). Mitochondrial biogenesis in striated muscle. Can J Appl Physiol 19, 12–48.

Lin J, Wu H, Tarr PT, Zhang CY, Wu Z, Boss O, et al. (2002). Transcriptional co-activator PGC-1 alpha drives the formation of slow-twitch muscle fibres. Nature 418, 797–801.

Mauro A (1961). Satellite cell of skeletal muscle fibers. J Biophys Biochem Cytol 9, 493–495.McPherron AC, Lawler AM and Lee SJ (1997). Regulation of skeletal muscle mass in mice by a new TGF-beta superfamily member. Nature 387, 83–90.

Morange M (2009). History of molecular biology. In Encyclopedia of life sciences. John Wiley & Sons, Chichester.

Murgia M, Serrano AL, Calabria E, Pallafacchina G, Lomo T and Schiaffino S (2000). Ras is involved in nerve-activity-dependent regulation of muscle genes. Nat Cell Biol 2, 142–147.

Pallafacchina G, Calabria E, Serrano AL, Kalhovde JM and Schiaffino S (2002). A protein kinase B-dependent and rapamycin-sensitive pathway controls skeletal muscle growth but not fiber type specification. Proc Natl Acad Sci U S A 99, 9213–9218.

Puigserver P, Wu Z, Park CW, Graves R, Wright M and Spiegelman BM (1998). A cold-inducible coactivator of nuclear receptors linked to adaptive thermogenesis. Cell 92, 829–839.

Scarpulla RC (1997). Nuclear control of respiratory chain expression in mammalian cells. J Bioenerg Biomembr 29, 109–119.

Schuelke M, Wagner KR, Stolz LE, Hubner C, Riebel T, Komen W, et al. (2004). Myostatin mutation associated with gross muscle hypertrophy in a child. N Engl J Med 350, 2682–2688.

Spurway NC and Wackerhage H (2006). Genetics and molecular biology of muscle adaptation. Elsevier/Churchill Livingstone, Edinburgh.

omason DB and Booth FW (1990). Stable incorporation of a bacterial gene into adult rat skeletal muscle in vivo. Am J Physiol 258, C578–C581.

Timmons JA, Knudsen S, Rankinen T, Koch LG, Sarzynski M, Jensen T, et al. (2010). Using molecular classification to predict gains in maximal aerobic capacity following endurance exercise training in humans. J Appl Physiol 108, 1487–1496.

Wackerhage H, Miah A, Harris RC, Montgomery HE and Williams AG (2009). Genetic research and testing in sport and exercise science: A review of the issues. J Sports Sci 1–8.

Watson PA, Stein JP and Booth FW (1984). Changes in actin synthesis and alpha-actin-mRNA content in rat muscle during immobilization. Am J Physiol 247, C39–C44.

Wheeler DA, Srinivasan M, Egholm M, Shen Y, Chen L, McGuire A, et al. (2008). e complete genome of an individual by massively parallel DNA sequencing. Nature 452, 872–876.

Williams AG, Rayson MP, Jubb M, World M, Woods DR, Hayward M, et al. (2000). e ACE gene and muscle performance. Nature 403, 614.

Winder WW and Hardie DG (1996). Inactivation of acetyl-CoA carboxylase and activation of AMP-activated protein kinase in muscle during exercise. Am J Physiol 270, E299–E304.

Wolff JA, Malone RW, Williams P, Chong W, Acsadi G, Jani A and Felgner PL (1990). Direct gene transfer into mouse muscle in vivo. Science 247, 1465–1468.

Yamaguchi M, Nakayama Y and Nishikawa J (1985). Studies on exercise and an elastic protein “connectin” in hindlimb muscle of growing rat. Jpn J Physiol 35, 21–32.

Zammit PS, Golding JP, Nagata Y, Hudon V, Partridge TA and Beauchamp JR (2004). Muscle satellite cells adopt divergent fates: a mechanism for self-renewal? J Cell Biol 166, 347–357.

■ جهت مطالعه بیشتر

Bouchard C, Malina RM, and Perusse L (1997). Genetics of fitness and physical performance. Human Kinetics, Champaign, IL.

Bouchard C and Hoffman EP (2011). Genetic and molecular aspects of sports performance, Vol. 18 of Encyclopedia of sports medicine. John Wiley & Sons, Chichester.

Pescatello LS and Roth SM (2011). Exercise genomics. Springer, New York.

Roth SM (2007). Genetics primer for exercise science and health. Human Kinetics, champaign, IL.

Roth SM (2008). Perspective on the future use of genomics in exercise prescription. j Appl Physiol 104, 1243–1245.

Wackerhage H, Miah A, Harris RC, Montgomery HE and Williams AG (2009). Genetic research and testing in sport and exercise science: A review of the issues. J Sports Sci 1–8.

■ منابع

Ahmetov II, Williams AG, Popov DV, Lyubaeva EV, Hakimullina AM, Fedotovskaya ON, et al. (2009). the combined impact of metabolic gene polymorphisms on elite endurance athlete status and related phenotypes. Hum Genet 126, 751–761.

Altmuller J, Palmer LJ, Fischer G, Scherb H and Wjst M (2001). Genomewide scans of complex human diseases: true linkage is hard to find. Am J Hum Genet 69, 936–950.

Bernstein BE, Birney E, Dunham I, Green ED, Gunter C and Snyder M (2012). An integrated encyclopedia of DNA elements in the human genome. Nature 489, 57–74.

Bouchard C (2011). Overcoming barriers to progress in exercise genomics. Exerc Sport Sci Rev 39, 212–217.

Bouchard C, Leon AS, Rao DC, Skinner JS, Wilmore JH and Gagnon J (1995). the HERITAGE family study. Aims, design, and measurement protocol. Med Sci Sports Exerc 27, 721–729.
Bouchard C, An P, Rice T, Skinner JS, Wilmore JH, Gagnon J, et al. (1999). Familial aggregation of V.O(2max) response to exercise training: results from the HERITAGE Family Study. J Appl Physiol 87, 1003–1008.
Bouchard C, Sarzynski MA, Rice TK, Kraus WE, Church TS, Sung YJ, et al. (2011). Genomic predictors of the maximal O uptake response to standardized exercise training programs. J Appl Physiol 110, 1160–1170.
Bouchard C, Blair SN, Church TS, Earnest CP, Hagberg JM, Hakkinen K, et al. (2012). Adverse metabolic response to regular exercise: is it a rare or common occurrence? PLoS ONE 7, e37887.
Bray MS, Hagberg JM, Perusse L, Rankinen T, Roth SM, Wolfarth B, et al. (2009). the human gene map for performance and health-related fitness phenotypes: the 2006–2007 update. Med Sci Sports Exerc 41, 35–73.
Bruder CE, Piotrowski A, Gijsbers AA, Andersson R, Erickson S, Diaz de Ståhl T, et al. (2008). Phenotypically concordant and discordant monozygotic twins display different DNA copy-number-variation profiles. Am J Hum Genet 82, 763–771.
Chanock SJ, Manolio T, Boehnke M, Boerwinkle E, Hunter DJ, omas G, et al. (2007). Replicating genotype-phenotype associations. Nature 447, 655–660.
de la Chapelle A, Traskelin AL and Juvonen E (1993). Truncated erythropoietin receptor causes dominantly inherited benign human erythrocytosis. Proc Natl Acad Sci U S A 90, 4495–4499.
Falconer DS and MacKay TFS (2011). Introduction to quantitative genetics, 4 ed. Longmans Green, Harlow, Essex.
Friedmann T (2010). How close are we to gene doping? Hastings Cent Rep 40, 20–22.
Genetic Technologies Ltd (2007). ACTN3 sport performance test TM . http://www.gtg.com.au/archives/migration/2/010/5/ACTN3%20web%20brochure.pdf.
Hakimi P, Yang J, Casadesus G, Massillon D, Tolentino-Silva F, Nye CK, et al. (2007). Overexpression of the cytosolic form of phosphoenolpyruvate carboxykinase (GTP) in skeletal muscle repatterns energy metabolism in the mouse. J Biol Chem 282, 32844–32855.
Kidd JM, Cooper GM, Donahue WF, Hayden HS, Sampas N, Graves T, et al. (2008). Mapping and sequencing of structural variation from eight human genomes. Nature 453, 56–64.
Lettre G, Jackson AU, Gieger C, Schumacher FR, Berndt SI, Sanna S, et al. (2008). Identification of ten loci associated with height highlights new biological pathways in human growth. Nat Genet 40, 584–591.
Lin J, Wu H, Tarr PT, Zhang CY, Wu Z, Boss O, et al. (2002). Transcriptional co-activator PGC-1 alpha drives the formation of slow-twitch muscle fibres. Nature 418, 797–801.
Lionikas A, Cheng R, Lim JE, Palmer AA and Blizard DA (2010). Fine-mapping of muscle weight QTL in LG/J and SM/J intercrosses. Physiol Genomics 42A, 33–38.
McPherron AC, Lawler AM and Lee SJ (1997). Regulation of skeletal muscle mass in mice by a new TGF-beta superfamily member. Nature 387, 83–90.
Mullis KB (1990). the unusual origin of the polymerase chain reaction. Sci Am 262, 64–65.
North KN, Yang N, Wattanasirichaigoon D, Mills M, Easteal S and Beggs AH (1999). A common nonsense mutation results in alpha-actinin-3 deficiency in the general population. Nat Genet 21, 353–354.
Pray LA (2008). DNA replication and causes of mutation. Nature Education 1.
Rigat B, Hubert C, Alhenc-Gelas F, Cambien F, Corvol P and Soubrier F (1990). An insertion/deletion polymorphism in the angiotensin I-converting enzyme gene accounting for half the variance of serum enzyme levels. J Clin Invest 86, 1343–1346.
Roth SM (2008). Perspective on the future use of genomics in exercise prescription. J Appl Physiol 104, 1243–1245.
Saiki RK, Gelfand DH, Stoffel S, Scharf SJ, Higuchi R, Horn GT, et al. (1988). Primer-directed enzymatic amplification of DNA with a thermostable DNA polymerase. Science 239, 487–491.
Schork NJ, Murray SS, Frazer KA and Topol EJ (2009). Common vs. rare allele hypotheses for complex diseases. Curr Opin Genet Dev 19, 212–219.
Schuelke M, Wagner KR, Stolz LE, Hubner C, Riebel T, Komen W, et al. (2004). Myostatin mutation associated with gross muscle hypertrophy in a child. N Engl J Med 350, 2682–2688.
Smits J and Monden C (2011). Twinning across the developing world. PLoS ONE 6, e25239.
Strachan T and Read AP (2004). Human molecular genetics, 3rd edn. Garland Science, New York, Oxford.
Strittmatter WJ, Saunders AM, Schmechel D, Pericak-Vance M, Enghild J, Salvesen GS, et al. (1993). Apolipoprotein E: high-avidity binding to beta-amyloid and increased frequen-

cy of type 4 allele in late-onset familial Alzheimer disease. Proc Natl Acad Sci U S A 90, 1977–1981.
Tamaki K and Jeffreys AJ (2005). Human tandem repeat sequences in forensic DNA typing. Leg Med (Tokyo) 7, 244–250.

Thomas S, Reading J and Shephard RJ (1992). Revision of the Physical Activity Readiness Questionnaire (PAR-Q). Can J Sport Sci 17, 338–345.

Thomis MA, Beunen GP, Maes HH, Blimkie CJ, Van LM, Claessens AL, et al. (1998). Strength training: importance of genetic factors. Med Sci Sports Exerc 30, 724–731.

Timmons JA, Knudsen S, Rankinen T, Koch LG, Sarzynski M, Jensen T, et al. (2010). Using molecular classification to predict gains in maximal aerobic capacity following endurance exercise training in humans. J Appl Physiol 108, 1487–1496.

Wackerhage H, Miah A, Harris RC, Montgomery HE and Williams AG (2009). Genetic research and testing in sport and exercise science: A review of the issues. J Sports Sci 1–8.

Consortium (2007). Genome-wide association study of 14,000 cases of seven common diseases and 3,000 shared controls. Nature 447, 661–678.

Wheeler DA, Srinivasan M, Egholm M, Shen Y, Chen L, McGuire A, et al. (2008). The complete genome of an individual by massively parallel DNA sequencing. Nature 452, 872–876.

World Anti-Doping Code (2009). http://www.wada-ama.org/en/world-anti-doping-program/sports-and-anti-doping-organizations/the-code/.

Yang N, MacArthur DG, Gulbin JP, Hahn AG, Beggs AH, Easteal S, et al. (2003). ACTN3 genotype is associated with human elite athletic performance. Am J Hum Genet 73, 627–631.

■ جهت مطالعه بیشتر

Burniston JG and Hoffman EP (2011). Proteomic responses of skeletal and cardiac muscle to exercise. Exp Rev Proteomics 8, 361–77.

■ منابع

Aldridge GM, Podrebarac DM, Greenough WT and Weiler IJ (2008). the use of total protein stains as loading controls: an alternative to high-abundance single-protein controls in semi-quantitative immunoblotting. J Neurosci Methods 172, 250–254.

Alonso A, Sasin J, Bottini N, Friedberg I, Friedberg I, Osterman A, et al. (2004). Protein tyrosine phosphatases in the human genome. Cell 117, 699–711.

Baar K and Esser K (1999). Phosphorylation of p70(S6k) correlates with increased skeletal muscle mass following resistance exercise. Am J Physiol 276, C120–C127.

Bergstrom J and Hultman E (1966). Muscle glycogen synthesis after exercise: an enhancing factor localized to the muscle cells in man. Nature 210, 309–310.

Bodine SC, Latres E, Baumhueter S, Lai VK, Nunez L, Clarke BA, et al. (2001). Identification of ubiquitin ligases required for skeletal muscle atrophy. Science 294, 1704–1708.

Burnette WN (1981). “Western blotting”: electrophoretic transfer of proteins from sodium dodecyl sulfate—polyacrylamide gels to unmodified nitrocellulose and radiographic detection with antibody and radioiodinated protein A. Anal Biochem 112, 195–203.

Burniston JG (2008). Changes in the rat skeletal muscle proteome induced by moderate-intensity endurance exercise. Biochim Biophys Acta 1784, 1077–1086.

Burniston JG, Meek TH, Pandey SN, Broitman-Maduro G, Maduro MF, Bronikowski AM, et al. (2013). Gene expression profiling of gastrocnemius of “minimuscle” mice. Physiol Genomics 45, 228–236.

Campbell WG, Gordon SE, Carlson CJ, Pattison JS, Hamilton MT and Booth FW (2001). Differential global gene expression in red and white skeletal muscle. Am J Physiol Cell Physiol 280, C763–C768.

Cao Y, Yao Z, Sarkar D, Lawrence M, Sanchez GJ, Parker MH, et al. (2010). Genome-wide MyoD binding in skeletal muscle cells: a potential for broad cellular reprogramming. Dev Cell 18, 662–674.

Chin ER, Olson EN, Richardson JA, Yang Q, Humphries C, Shelton JM, et al. (1998). A calcineurin-dependent transcriptional pathway controls skeletal muscle fiber type. Genes Dev 12, 2499–2509.

Chomczynski P and Sacchi N (1987). Single-step method of RNA isolation by acid guanidinium thiocyanate-phenol-chloroform extraction. Anal Biochem 162, 156–159.

Cohen P (2002). the origins of protein phosphorylation. Nat Cell Biol 4, E127–E130.

Davidsen PK, Gallagher IJ, Hartman JW, Tarnopolsky MA, Dela F, Helge JW, et al. (2011). High responders to resistance exercise training demonstrate differential regulation of skeletal muscle microRNA expression. J Appl Physiol 110, 309–317.

Dunham I, Kundaje A, Aldred SF, Collins PJ, Davis CA, Doyle F, et al. (2012). An integrated encyclopedia of DNA elements in the human genome. Nature 489, 57–74.

Erce MA, Pang CN, Hart-Smith G and Wilkins MR (2012). the methylproteome and the intracellular methylation network. Proteomics 12, 564–586.

Fischer EH and Krebs EG (1955). Conversion of phosphorylase b to phosphorylase a in muscle extracts. J Biol Chem 216, 121–132.

Fuda NJ, Ardehali MB and Lis JT (2009). Defining mechanisms that regulate RNA polymerase II transcription in vivo. Nature 461, 186–192.

Glickman MH and Ciechanover A (2002). the ubiquitin-proteasome proteolytic pathway: destruction for the sake of construction. Physiol Rev 82, 373–428.

Gordon PM, Liu D, Sartor MA, IglayReger HB, Pistilli EE, Gutmann L, et al. (2012). Resistance exercise training influences skeletal muscle immune activation: a microarray analysis. J Appl Physiol 112, 443–453.

Hardie DG, Ross FA and Hawley SA (2012). AMPK: a nutrient and energy sensor that maintains energy homeostasis. Nat Rev Mol Cell Biol 13, 251–262.

He C, Sumpter R, Jr. and Levine B (2012). Exercise induces autophagy in peripheral tissues and in the brain. Autophagy 8, 1548–1551.

Henriksson J, Salmons S and Lowry OH (1989). Chronic stimulation of mammalian muscle: enzyme and metabolic changes in individual fibres. Biomed Biochim Acta 48, S445–S454.

Holloway KV, O'Gorman M, Woods P, Morton JP, Evans L, Cable NT, et al. (2009). Proteomic investigation of changes in human vastus lateralis muscle in response to interval-exercise training. Proteomics 9, 5155–5174.

Hornberger TA (2011). Mechanotransduction and the regulation of mTORC1 signaling in skeletal muscle. Int J Biochem Cell Biol 43, 1267–1276.

Ilsley JL, Sudol M and Winder SJ (2002). the WW domain: linking cell signalling to the membrane cytoskeleton. Cell Signal 14, 183–189.

Johnson ES (2004). Protein modification by SUMO. Annu Rev Biochem 73, 355–382.

Keller P, Vollaard NB, Gustafsson T, Gallagher IJ, Sundberg CJ, Rankinen T, et al. (2011). A transcriptional map of the impact of endurance exercise training on skeletal muscle phenotype. J Appl Physiol 110, 46–59.

Koutedakis Y, Metsios GS and Stavropoulos-Kalinoglou A (2006). Periodization of exercise training in sport. In The physiology of training, ed. MacLaren D, pp. 1–21. Elsevier, Edinburgh.

Laemmli UK (1970). Cleavage of structural proteins during the assembly of the head of bacteriophage T4. Nature 227, 680–685.

Li W, Bengtson MH, Ulbrich A, Matsuda A, Reddy VA, Orth A, et al. (2008). Genome-wide and functional annotation of human E3 ubiquitin ligases identifies MULAN, a mitochondrial E3 that regulates the organelle's dynamics and signaling. PLoS ONE 3, e1487.

Manning G, Whyte DB, Martinez R, Hunter T and Sudarsanam S (2002). the protein kinase complement of the human genome. Science 298, 1912–1934.

McCarthy JJ and Esser KA (2007). MicroRNA-1 and microRNA-133a expression are decreased during skeletal muscle hypertrophy. J Appl Physiol 102, 306–313.

McGee SL and Hargreaves M (2011). Histone modifications and exercise adaptations. J Appl Physiol 110, 258–263.

Mischerikow N and Heck AJ (2011). Targeted large-scale analysis of protein acetylation. Proteomics 11, 571–589.

Ohtsubo K and Marth JD (2006). Glycosylation in cellular mechanisms of health and disease. Cell 126, 855–867.

Park KD, Park J, Ko J, Kim BC, Kim HS, Ahn K, et al. (2012). Whole transcriptome analyses of six thoroughbred horses before and after exercise using RNA-Seq. BMC Genomics 13, 473.

Parker KC, Walsh RJ, Salajegheh M, Amato AA, Krastins B, Sarracino DA, et al. (2009). Characterization of human skeletal muscle biopsy samples using shotgun proteomics. J Proteome Res 8, 3265–3277.

Pearen MA, Myers SA, Raichur S, Ryall JG, Lynch GS and Muscat GE (2008). the orphan nuclear receptor, NOR-1, a target of beta-adrenergic signaling, regulates gene expression that controls oxidative metabolism in skeletal muscle. Endocrinology 149, 2853–2865. Renart J,

Reiser J and Stark GR (1979). Transfer of proteins from gels to diazobenzyloxymethyl-paper and detection with antisera: a method for studying antibody specificity and antigen structure. Proc Natl Acad Sci U S A 76, 3116–3120.

Resh MD (2006). Trafficking and signaling by fatty-acylated and prenylated proteins. Nat Chem Biol 2, 584–590.

Roff M, Thompson J, Rodriguez MS, Jacque JM, Baleux F, Arenzana-Seisdedos F, et al. (1996). Role of IkappaBalpha ubiquitination in signal-induced activation of NFkappaB in vivo. J Biol Chem 271, 7844–7850.

Safdar A, Abadi A, Akhtar M, Hettinga BP and Tarnopolsky MA (2009). miRNA in the regulation of skeletal muscle adaptation to acute endurance exercise in C57Bl/6J male mice. PLoS ONE 4, e5610.

Sanyal A, Lajoie BR, Jain G and Dekker J (2012). e long-range interaction landscape of gene promoters. Nature 489, 109–113.

Scarpulla RC (2002). Nuclear activators and coactivators in mammalian mitochondrial biogenesis. Biochim Biophys Acta 1576, 1–14.

Tintignac LA, Lagirand J, Batonnet S, Sirri V, Leibovitch MP and Leibovitch SA (2005). Degradation of MyoD mediated by the SCF (MAFbx) ubiquitin ligase. J Biol Chem 280, 2847–2856.

Toole BJ and Cohen PT (2007). the skeletal muscle-specific glycogen-targeted protein phosphatase 1 plays a major role in the regulation of glycogen metabolism by adrenaline in vivo. Cell Signal 19, 1044–1055.

Towbin H, Staehelin T and Gordon J (1979). Electrophoretic transfer of proteins from polyacrylamide gels to nitrocellulose sheets: procedure and some applications. Proc Natl Acad Sci U S A 76, 4350–4354.

Ulbricht A and Hohfeld J (2013). Tension-induced autophagy: May the chaperone be with you. Autophagy 9.

Valencia-Sanchez MA, Liu J, Hannon GJ and Parker R (2006). Control of translation and mRNA degradation by miRNAs and siRNAs. Genes Dev 20, 515–524.

Vaquerizas JM, Kummerfeld SK, Teichmann SA and Luscombe NM (2009). A census of human transcription factors: function, expression and evolution. Nat Rev Genet 10, 252–263.

Wolff J (1892). Das Gesetz der Transformation der Knochen. Springer, Berlin.

Yang S, Alnaqeeb M, Simpson H and Goldspink G (1996). Cloning and characterization of an IGF-1 isoform expressed in skeletal muscle subjected to stretch. J Muscle Res Cell Motil 17, 487–495.

■ جهت مطالعه بیشتر

Egan B and Zierath JR (2013). Exercise metabolism and the molecular regulation of skeletal muscle adaptation. Cell Metab 17, 162–184.

Hardie DG (2011). Energy sensing by the AMP-activated protein kinase and its effects on muscle metabolism. Proc Nutr Soc 70, 92–99.

Schiaffino S (2010). Fibre types in skeletal muscle: a personal account. Acta Physiol (Oxford) 199, 451–463.

■ منابع

Ameln H, Gustafsson T, Sundberg CJ, Okamoto K, Jansson E, Poellinger L, et al. (2005).
Physiological activation of hypoxia inducible factor-1 in human skeletal muscle. FASEB J 19, 1009–1011.

Andersen P and Henriksson J (1977). Capillary supply of the quadriceps femoris muscle of man: adaptive response to exercise. J Physiol 270, 677–690.

Arany Z, Foo SY, Ma Y, Ruas JL, Bommi-Reddy A, Girnun G, et al. (2008). HIF-independentregulation of VEGF and angiogenesis by the transcriptional coactivator PGC-1alpha. Nature 451,1008–1012.

Asp P, Blum R, Vethantham V, Parisi F, Micsinai M, Cheng J, et al. (2011). Genome-wide remodeling of the epigenetic landscape during myogenic differentiation. Proc Natl Acad Sci U S A 108,E149–E158.

Baar K, Wende AR, Jones TE, Marison M, Nolte LA, Chen M, et al. (2002). Adaptations of skeletalmuscle to exercise: rapid increase in the transcriptional coactivator PGC-1. FASEB J 16, 1879–1886.

Barany M (1967). ATPase activity of myosin correlated with speed of muscle shortening. J Gen Physiol50, Suppl 218.

Barres R, Yan J, Egan B, Treebak JT, Rasmussen M, Fritz T, et al. (2012). Acute exercise remodelspromoter methylation in human skeletal muscle. Cell Metab 15, 405–411.

Bassett DR, Jr. and Howley ET (2000). Limiting factors for maximum oxygen uptake and determinants of endurance performance. Med Sci Sports Exerc 32, 70–84.

Berchtold MW, Brinkmeier H and Muntener M (2000). Calcium ion in skeletal muscle: its crucialrole for muscle function, plasticity, and disease. Physiol Rev 80, 1215–1265.

Bernardo BC, Weeks KL, Pretorius L and McMullen JR (2010). Molecular distinction between physiological and pathological cardiac hypertrophy: experimental findings and therapeutic strategies.Pharmacol Ther 128, 191–227.

Biering-Sorensen B, Kristensen IB, Kjaer M and Biering-Sorensen F (2009). Muscle after spinal cordinjury. Muscle Nerve 40, 499–519.

Blomqvist CG and Saltin B (1983). Cardiovascular adaptations to physical training. Annu Rev Physiol45, 169–189.

Bostrom P, Mann N, Wu J, Quintero PA, Plovie ER, Panakova D, et al. (2010). C/EBPbeta controlsexercise-induced cardiac growth and protects against pathological cardiac remodeling. Cell 143,1072–1083.

Bouchard C, An P, Rice T, Skinner JS, Wilmore JH, Gagnon J, et al. (1999). Familial aggregation of.VO(2max) response to exercise training: results from the HERITAGE Family Study. J Appl Physiol87, 1003–1008.

Bouchard C, Sarzynski MA, Rice TK, Kraus WE, Church TS, Sung YJ, et al. (2011). Genomic predictors of the maximal O uptake response to standardized exercise training programs. J Appl Physiol110, 1160–1170.

Bouchard C, Blair SN, Church TS, Earnest CP, Hagberg JM, Hakkinen K, et al. (2012). Adversemetabolic response to regular exercise: is it a rare or common occurrence? PLoS ONE 7, e37887.

Brodal P, Ingjer F and Hermansen L (1977). Capillary supply of skeletal muscle fibers in untrainedand endurance-trained men. Am J Physiol 232, H705–H712.

Bueno OF, De Windt LJ, Tymitz KM, Witt SA, Kimball TR, Klevitsky R, et al. (2000). The MEK1-ERK1/2 signaling pathway promotes compensated cardiac hypertrophy in transgenic mice.EMBO J 19, 6341–6350.

Buller AJ, Eccles JC and Eccles RM (1960). Interactions between motoneurones and muscles inrespect of the characteristic speeds of their responses. J Physiol 150, 417–439.

Canto C, Gerhart-Hines Z, Feige JN, Lagouge M, Noriega L, Milne JC, et al. (2009). AMPK regulates energy expenditure by modulating NAD metabolism and SIRT1 activity. Nature 458,1056–1060.

Carling D, Thornton C, Woods A and Sanders MJ (2012). AMP-activated protein kinase: new regulation, new roles? Biochem J 445, 11–27.

Carroll SL, Klein MG and Schneider MF (1997). Decay of calcium transients after electrical stimulation in rat fast- and slow-twitch skeletal muscle fibres. J Physiol 501 (Pt 3), 573–588.Chin ER (2005). Role of Ca2/calmodulin-dependent kinases in skeletal muscle plasticity. J ApplPhysiol 99, 414–423.

Chin ER, Olson EN, Richardson JA, Yang Q, Humphries C, Shelton JM, et al. (1998). A calcineurindependent transcriptional pathway controls skeletal muscle fiber type. Genes Dev 12, 2499–2509.

Costill DL, Daniels J, Evans W, Fink W, Krahenbuhl G and Saltin B (1976a). Skeletal muscle enzymesand fiber composition in male and female track athletes. J Appl Physiol 40, 149–154.

Costill DL, Fink WJ and Pollock ML (1976b). Muscle fiber composition and enzyme activities of elitedistance runners. Med Sci Sports 8, 96–100.

DeBosch B, Treskov I, Lupu TS, Weinheimer C, Kovacs A, Courtois M, et al. (2006). Akt1 is requiredfor physiological cardiac growth. Circulation 113, 2097–2104.

Egan B and Zierath JR (2013). Exercise metabolism and the molecular regulation of skeletal muscleadaptation. Cell Metab 17, 162–184.

Ekblom B (1968). Effect of physical training on oxygen transport system in man. Acta Physiol ScandSuppl 328, 1–45.

Gan Z, Burkart-Hartman EM, Han DH, Finck B, Leone TC, Smith EY, et al. (2011). The nuclearreceptor PPARbeta/delta programs muscle glucose metabolism in cooperation with AMPK andMEF2. Genes Dev 25, 2619–2630.

Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, et al. (2011). American College of Sports Medicine position stand. Quantity and quality of exercise for developingand maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthyadults: guidance for prescribing exercise. Med Sci Sports Exerc 43, 1334–1359.

Gibala MJ, Little JP, MacDonald MJ and Hawley JA (2012). Physiological adaptations to low-volume, high-intensity interval training in health and disease. J Physiol 590, 1077–1084.

Gollnick PD, Armstrong RB, Saltin B, Saubert CW, Sembrowich WL and Shepherd RE (1973).Effect of training on enzyme activity and fiber composition of human skeletal muscle. J Appl Physiol34, 107–111.

Haas TL, Milkiewicz M, Davis SJ, Zhou AL, Egginton S, Brown MD, et al. (2000). Matrix metalloproteinase activity is required for activity-induced angiogenesis in rat skeletal muscle. Am J PhysiolHeart Circ Physiol 279, H1540–H1547.

Hardie DG and Sakamoto K (2006). AMPK: a key sensor of fuel and energy status in skeletal muscle.Physiology (Bethesda) 21, 48–60.

Harridge SD, Bottinelli R, Canepari M, Pellegrino MA, Reggiani C, Esbjornsson M, et al. (1996).Whole-muscle and single-fibre contractile properties and myosin heavy chain isoforms in humans.Pflugers Arch 432, 913–920.

Hennig R and Lomo T (1985). Firing patterns of motor units in normal rats. Nature 314, 164–166.

Holloszy JO (1967). Biochemical adaptations in muscle. Effects of exercise on mitochondrial oxygenuptake and respiratory enzyme activity in skeletal muscle. J Biol Chem 242, 2278–2282.

Hudlicka O, Brown MD and Silgram H (2000). Inhibition of capillary growth in chronically stimulatedrat muscles by N(G)-nitro-1-arginine, nitric oxide synthase inhibitor. Microvasc Res 59, 45–51.

Hughes SM, Chi MM, Lowry OH and Gundersen K (1999). Myogenin induces a shift of enzymeactivity from glycolytic to oxidative metabolism in muscles of transgenic mice. J Cell Biol 145,633–642.

Ingalls CP (2004). Nature vs. nurture: can exercise really alter fiber type composition in human skeletal muscle? J Appl Physiol 97, 1591–1592.

Ingjer F (1979). Effects of endurance training on muscle fibre ATP-ase activity, capillary supply andmitochondrial content in man. J Physiol 294, 419–432.

Jager S, Handschin C, St-Pierre J and Spiegelman BM (2007). AMP-activated protein kinase (AMPK)action in skeletal muscle via direct phosphorylation of PGC-1alpha. Proc Natl Acad Sci U S A 104,12017–12022

Jansson E and Kaijser L (1977). Muscle adaptation to extreme endurance training in man. Acta PhysiolScand 100, 315–324.

Jenuwein T and Allis CD (2001). Translating the histone code. Science 293, 1074–1080.

Johnson MA, Polgar J, Weightman D and Appleton D (1973). Data on the distribution of fibre typesin thirty-six human muscles. An autopsy study. J Neurol Sci 18, 111–129.

Jones D, Round J and de Haan A (2004). Skeletal muscle. From molecules to movement. ChurchillLivingstone, Edinburgh.

Knutti D, Kressler D and Kralli A (2001). Regulation of the transcriptional coactivator PGC-1 viaMAPK-sensitive interaction with a repressor. Proc Natl Acad Sci U S A 98, 9713–9718.

Lassar AB, Paterson BM and Weintraub H (1986). Transfection of a DNA locus that mediates theconversion of 10T1/2 fibroblasts to myoblasts. Cell 47, 649–656.

Lexell J, Taylor CC and Sjostrom M (1988). What is the cause of the ageing atrophy? Total number,size and proportion of different fiber types studied in whole vastus lateralis muscle from 15- to83-year-old men. J Neurol Sci 84, 275–294.

Lin J, Wu H, Tarr PT, Zhang CY, Wu Z, Boss O, et al. (2002). Transcriptional co-activator PGC-1alpha drives the formation of slow-twitch muscle fibres. Nature 418, 797–801.

Mason SD, Howlett RA, Kim MJ, Olfert IM, Hogan MC, McNulty W, et al. (2004). Loss of skeletalmuscle HIF-1alpha results in altered exercise endurance. PLoS Biol 2, e288.

McKinsey TA, Zhang CL and Olson EN (2001). Control of muscle development by dueling HATsand HDACs. Curr Opin Genet Dev 11, 497–504.

McMullen JR, Shioi T, Zhang L, Tarnavski O, Sherwood MC, Kang PM, et al. (2003). Phosphoinositide 3-kinase(p110alpha) plays a critical role for the induction of physiological, but not pathological, cardiac hypertrophy. Proc Natl Acad Sci U S A 100, 12355–12360.

McPhee JS, Williams AG, Stewart C, Baar K, Schindler JP, Aldred S, et al. (2009). The training stimulus experienced

by the leg muscles during cycling in humans. Exp Physiol 94, 684–694.
Meyer RA and Foley JM (1996). Cellular processes integrating the metabolic response to exercise.In Handbook of Physiology. Section 12. Exercise: Regulation and Integration of multiple Systems, eds.Rowell LB and Shepherd JT, pp. 841–869. Oxford University Press, Oxford.
Midgley AW, McNaughton LR and Jones AM (2007). Training to enhance the physiological determinants of long-distance running performance: can valid recommendations be given to runners andcoaches based on current scientific knowledge? Sports Med 37, 857–880.
Molkentin JD, Lu JR, Antos CL, Markham B, Richardson J, Robbins J, et al. (1998). A calcineurindependent transcriptional pathway for cardiac hypertrophy. Cell 93, 215–228.
Murgia M, Serrano AL, Calabria E, Pallafacchina G, Lomo T and Schiaffino S (2000). Ras is involvedin nerve-activity-dependent regulation of muscle genes. Nat Cell Biol 2, 142–147.
Naya FJ, Mercer B, Shelton J, Richardson JA, Williams RS and Olson EN (2000). Stimulation of slowskeletal muscle fiber gene expression by calcineurin in vivo. J Biol Chem 275, 4545–4548.
Ouchi N, Shibata R and Walsh K (2005). AMP-activated protein kinase signaling stimulates VEGFexpression and angiogenesis in skeletal muscle. Circ Res 96, 838–846.
Pandorf CE, Haddad F, Wright C, Bodell PW and Baldwin KM (2009). Differential epigenetic modifications of histones at the myosin heavy chain genes in fast and slow skeletal muscle fibers and inresponse to muscle unloading. Am J Physiol Cell Physiol 297, C6–16.
Parsons SA, Wilkins BJ, Bueno OF and Molkentin JD (2003). Altered skeletal muscle phenotypes incalcineurin Aalpha and Abeta gene-targeted mice. Mol Cell Biol 23, 4331–4343.
Parsons SA, Millay DP, Wilkins BJ, Bueno OF, Tsika GL, Neilson JR, et al. (2004). Genetic lossof calcineurin blocks mechanical overload-induced skeletal muscle fiber-type switching but nothypertrophy. J Biol Chem 279, 26192–26220.
Pette D and Vrbova G (1992). Adaptation of mammalian skeletal muscle fibers to chronic electricalstimulation. Rev Physiol Biochem Pharmacol 120, 115–202.
Philp A, Chen A, Lan D, Meyer GA, Murphy AN, Knapp AE, et al. (2011). Sirtuin 1 (SIRT1) deacetylase activity is not required for mitochondrial biogenesis or peroxisome proliferator-activated receptor-gamma coactivator-1alpha (PGC-1alpha) deacetylation following endurance exercise.J Biol Chem 286, 30561–30570.
Pilegaard H, Saltin B and Neufer PD (2003). Exercise induces transient transcriptional activation ofthe PGC-1alpha gene in human skeletal muscle. J Physiol 546, 851–858.
Poyton RO and McEwen JE (1996). Crosstalk between nuclear and mitochondrial genomes. AnnuRev Biochem 65, 563–607.
Quiat D, Voelker KA, Pei J, Grishin NV, Grange RW, Bassel-Duby R, et al. (2011). Concerted regulation of myofiber-specific gene expression and muscle performance by the transcriptional repressorSox6. Proc Natl Acad Sci U S A 108, 10196–10201.
Rose AJ, Kiens B and Richter EA (2006). Ca2-calmodulin-dependent protein kinase expression andsignalling in skeletal muscle during exercise. J Physiol 574, 889–903.
Saltin B, Radegran G, Koskolou MD and Roach RC (1998). Skeletal muscle blood flow in humansand its regulation during exercise. Acta Physiol Scand 162, 421–436.
Sawka MN, Convertino VA, Eichner ER, Schnieder SM and Young AJ (2000). Blood volume: importance and adaptations to exercise training, environmental stresses, and trauma/sickness. Med SciSports Exerc 32, 332–348.
Scarpulla RC (2010). Metabolic control of mitochondrial biogenesis through the PGC-1 family regulatory network. Biochim Biophys Acta 1813, 1269–1278.
Scharhag J, Schneider G, Urhausen A, Rochette V, Kramann B and Kindermann W (2002). Athlete'sheart: right and left ventricular mass and function in male endurance athletes and untrained individuals determined by magnetic resonance imaging. J Am Coll Cardiol 40, 1856–1863.
Schiaffino S (2010). Fibre types in skeletal muscle: a personal account. Acta Physiol (Oxford) 199,451–463.
Shioi T, Kang PM, Douglas PS, Hampe J, Yballe CM, Lawitts J, et al. (2000). The conserved phosphoinositide 3-kinase pathway determines heart size in mice. EMBO J 19, 2537–2548.
Shioi T, McMullen JR, Kang PM, Douglas PS, Obata T, Franke TF, et al. (2002). Akt/protein kinaseB promotes organ growth in transgenic mice. Mol Cell Biol 22, 2799–2809.
Simoneau JA and Bouchard C (1995). Genetic determinism of fiber type proportion in human skeletalmuscle. FASEB

J 9, 1091–1095.
Smerdu V, Karsch-Mizrachi I, Campione M, Leinwand L and Schiaffino S (1994). Type IIx myosinheavy chain transcripts are expressed in type IIb fibers of human skeletal muscle. Am J Physiol 267,C1723–C1728.
Spurway NC and Wackerhage H (2006). Genetics and molecular biology of muscle adaptation. Elsevier/Churchill Livingstone, Edinburgh.
Suwa M, Nakano H and Kumagai S (2003). Effects of chronic AICAR treatment on fiber composition, enzyme activity, UCP3, and PGC-1 in rat muscles. J Appl Physiol 95, 960–968.
Timmons JA, Knudsen S, Rankinen T, Koch LG, Sarzynski M, Jensen T, et al. (2010). Using molecular classification to predict gains in maximal aerobic capacity following endurance exercise trainingin humans. J Appl Physiol 108, 1487–1496.
Tothova J, Blaauw B, Pallafacchina G, Rudolf R, Argentini C, Reggiani C, et al. (2006). NFATc1nucleocytoplasmic shuttling is controlled by nerve activity in skeletal muscle. J Cell Sci 119,1604–1611.
Towler MC and Hardie DG (2007). AMP-activated protein kinase in metabolic control and insulinsignaling. Circ Res 100, 328–341.
Trappe SW, Costill DL, Fink WJ and Pearson DR (1995). Skeletal muscle characteristics amongdistance runners: a 20-yr follow-up study. J Appl Physiol 78, 823–829.
Tseng BS, Kasper CE and Edgerton VR (1994). Cytoplasm-to-myonucleus ratios and succinate dehydrogenase activities in adult rat slow and fast muscle fibers. Cell Tissue Res 275, 39–49.
Tsika RW, Schramm C, Simmer G, Fitzsimons DP, Moss RL and Ji J (2008). Overexpression ofTEAD-1 in transgenic mouse striated muscles produces a slower skeletal muscle contractile phenotype. J Biol Chem 283, 36154–36167.
van Rooij E., Quiat D, Johnson BA, Sutherland LB, Qi X, Richardson JA, et al. (2009). A family ofmicroRNAs encoded by myosin genes governs myosin expression and muscle performance. DevCell 17, 662–673.
Wagner PD (2011). The critical role of VEGF in skeletal muscle angiogenesis and blood flow. BiochemSoc Trans 39, 1556–1559.
Weiss A, McDonough D, Wertman B, Acakpo-Satchivi L, Montgomery K, Kucherlapati R, et al.(1999). Organization of human and mouse skeletal myosin heavy chain gene clusters is highlyconserved. Proc Natl Acad Sci U S A 96, 2958–2963.
Wu H, Kanatous SB, Thurmond FA, Gallardo T, Isotani E, Bassel-Duby R, et al. (2002). Regulationof mitochondrial biogenesis in skeletal muscle by CaMK. Science 296, 349–352.
Xiao B, Sanders MJ, Underwood E, Heath R, Mayer FV, Carmena D, et al. (2011). Structure of mammalian AMPK and its regulation by ADP. Nature 472(7342), 230–233.
Xie K, Wei D, Shi Q and Huang S (2004). Constitutive and inducible expression and regulation ofvascular endothelial growth factor. Cytokine Growth Factor Rev 15, 297–324.
Yancopoulos GD, Davis S, Gale NW, Rudge JS, Wiegand SJ and Holash J (2000). Vascular-specificgrowth factors and blood vessel formation. Nature 407, 242–248.

جهت مطالعه بیشتر

Bouchard C and Hoffman EP (2011). Genetic and molecular aspects of sports performance, Vol. 18 of Encyclopedia of sports medicine. John Wiley & Sons, Chichester.
Bray MS, Hagberg JM, Perusse L, Rankinen T, Roth SM, Wolfarth B, et al. (2009). The human gene map for performance and health-related fitness phenotypes: the 2006–2007 update. Med Sci Sports Exerc 41, 35–73.
de la Chapelle A, Traskelin AL and Juvonen E (1993). Truncated erythropoietin receptor causes dominantly inherited benign human erythrocytosis. Proc Natl Acad Sci U S A 90, 4495–4499.
Hagberg JM, Rankinen T, Loos RJ, Perusse L, Roth SM, Wolfarth B, et al. (2011). Advances in exercise, fitness, and performance genomics in 2010. Med Sci Sports Exerc 43, 743–752.
Peeters MW, Thomis MA, Beunen GP and Malina RM (2009). Genetics and sports: an overview of the

pre-molecular biology era. Med Sport Sci 54, 28–42.
Pescatello LS and Roth SM (2011). Exercise genomics. Springer, New York.

■ منابع

Ahmetov II, Williams AG, Popov DV, Lyubaeva EV, Hakimullina AM, Fedotovskaya ON, et al. (2009). The combined impact of metabolic gene polymorphisms on elite endurance athlete status and related phenotypes. Hum Genet 126, 751–761.

Altmuller J, Palmer LJ, Fischer G, Scherb H and Wjst M (2001). Genomewide scans of complex human diseases: true linkage is hard to find. Am J Hum Genet 69, 936–950.

Anderson S, Bankier AT, Barrell BG, de Bruijn MH, Coulson AR, Drouin J, et al. (1981). Sequence and organization of the human mitochondrial genome. Nature 290, 457–465.

Bassett DR, Jr. and Howley ET (2000). Limiting factors for maximum oxygen uptake and determinants of endurance performance. Med Sci Sports Exerc 32, 70–84.

Bouchard C, Lesage R, Lortie G, Simoneau JA, Hamel P, Boulay MR, et al. (1986a). Aerobic performance in brothers, dizygotic and monozygotic twins. Med Sci Sports Exerc 18, 639–646.

Bouchard C, Simoneau JA, Lortie G, Boulay MR, Marcotte M and Thibault MC (1986b). Genetic effects in human skeletal muscle fiber type distribution and enzyme activities. Can J Physiol Pharmacol 64, 1245–1251.

Bouchard C, Daw EW, Rice T, Perusse L, Gagnon J, Province MA, et al. (1998). Familial resemblance for V . O 2max in the sedentary state: the HERITAGE family study. Med Sci Sports Exerc 30, 252–258.

Bouchard C, An P, Rice T, Skinner JS, Wilmore JH, Gagnon J, et al. (1999). Familial aggregation of .VO (2max) response to exercise training: results from the HERITAGE Family Study. J Appl Physiol 87, 1003–1008.

Bouchard C, Sarzynski MA, Rice TK, Kraus WE, Church TS, Sung YJ, et al. (2011). Genomic predictors of the maximal O uptake response to standardized exercise training programs. J Appl Physiol 110, 1160–1170.

Bray MS, Hagberg JM, Perusse L, Rankinen T, Roth SM, Wolfarth B, et al. (2009). The human gene map for performance and health-related fitness phenotypes: the 2006–2007 update. Med Sci Sports Exerc 41, 35–73.

Bueno OF, De Windt LJ, Tymitz KM, Witt SA, Kimball TR, Klevitsky R, et al. (2000). The MEK1-ERK1/2 signaling pathway promotes compensated cardiac hypertrophy in transgenic mice. EMBO J 19, 6341–6350. Castro MG, Terrados N, Reguero JR, Alvarez V and Coto E (2007).

Mitochondrial haplogroup T is negatively associated with the status of elite endurance athlete. Mitochondrion 7, 354–357.

hanock SJ, Manolio T, Boehnke M, Boerwinkle E, Hunter DJ, Thomas G, et al. (2007). Replicating genotype-phenotype associations. Nature 447, 655–660.

Cooper CE (2008). The biochemistry of drugs and doping methods used to enhance aerobic sport performance. Essays Biochem 44, 63–83.

Costill DL, Daniels J, Evans W, Fink W, Krahenbuhl G and Saltin B (1976a). Skeletal muscle enzymes and fiber composition in male and female track athletes. J Appl Physiol 40, 149–154

. Costill DL, Fink WJ and Pollock ML (1976b). Muscle fiber composition and enzyme activities of elite distance runners. Med Sci Sports 8, 96–100.

de la Chapelle A, Traskelin AL and Juvonen E (1993). Truncated erythropoietin receptor causes dominantly inherited benign human erythrocytosis. Proc Natl Acad Sci U S A 90, 4495–4499.

Defoor J, Martens K, Zielinska D, Matthijs G, Van NH, Schepers D, et al. (2006). The CAREGENE study: polymorphisms of the beta1-adrenoceptor gene and aerobic power in coronary artery disease. Eur Heart J 27, 808–816.

Eynon N, Meckel Y, Sagiv M, Yamin C, Amir R, Sagiv M, et al. (2010). Do PPARGC1A and PPARalpha polymorphisms influence sprint or endurance phenotypes? Scand J Med Sci Sports 20, e145–e150.

Eynon N, Moran M, Birk R and Lucia A (2011). The champions' mitochondria: is it genetically determined? A review on mitochondrial DNA and elite athletic performance. Physiol Genomics 43, 789–798.

Franks PW, Barroso I, Luan J, Ekelund U, Crowley VE, Brage S, et al. (2003). PGC-1alpha genotype modifies the association of volitional energy expenditure with [OV0312]O2max. Med Sci Sports Exerc 35, 1998–2004.

Hakimi P, Yang J, Casadesus G, Massillon D, Tolentino-Silva F, Nye CK, et al. (2007). Overexpression of the cytosolic form of phosphoenolpyruvate carboxykinase (GTP) in skeletal muscle repatterns energy metabolism in the mouse. J Biol Chem 282, 32844–32855.

Hautala AJ, Leon AS, Skinner JS, Rao DC, Bouchard C and Rankinen T (2007). Peroxisome proliferator-activated receptor-delta polymorphisms are associated with physical performance and plasma lipids: the HERITAGE Family Study. Am J Physiol Heart Circ Physiol 292, H2498–H2505.

Hill AV and Lupton H (1923). Muscular exercise, lactic acid and the supply and utilization of oxygen. Q J Med 16, 135–171.

Johnson MA, Polgar J, Weightman D and Appleton D (1973). Data on the distribution of fibre types in thirty-six human muscles. An autopsy study. J Neurol Sci 18, 111–129.

Klissouras V (1971). Heritability of adaptive variation. J Appl Physiol 31, 338–344.

Komi PV, Viitasalo JH, Havu M, Thorstensson A, Sjodin B and Karlsson J (1977). Skeletal muscle fibres and muscle enzyme activities in monozygous and dizygous twins of both sexes. Acta Physiol Scand 100, 385–392.

Lightfoot JT, Leamy L, Pomp D, Turner MJ, Fodor AA, Knab A, et al. (2010). Strain screen and haplotype association mapping of wheel running in inbred mouse strains. J Appl Physiol 109, 623–634.

Lin J, Wu H, Tarr PT, Zhang CY, Wu Z, Boss O, et al. (2002). Transcriptional co-activator PGC-1 alpha drives the formation of slow-twitch muscle fibres. Nature 418, 797–801.

Lucia A, Gomez-Gallego F, Barroso I, Rabadan M, Bandres F, San Juan AF, et al. (2005). PPARGC1A genotype (Gly482Ser) predicts exceptional endurance capacity in European men. J Appl Physiol 99, 344–348.

MacArthur DG, Seto JT, Chan S, Quinlan KG, Raftery JM, Turner N, et al. (2008). An Actn3 knockout mouse provides mechanistic insights into the association between alpha-actinin-3 deficiency and human athletic performance. Hum Mol Genet 17, 1076–1086.

Manchester J, Skurat AV, Roach P, Hauschka SD and Lawrence JC, Jr. (1996). Increased glycogen accumulation in transgenic mice overexpressing glycogen synthase in skeletal muscle. Proc Natl Acad Sci U S A 93, 10707–10711.

Martinez-Redondo D, Marcuello A, Casajus JA, Ara I, Dahmani Y, Montoya J, et al. (2010). Human mitochondrial haplogroup H: the highest V. O 2max consumer – is it a paradox? Mitochondrion 10, 102–107.

McCole SD, Shuldiner AR, Brown MD, Moore GE, Ferrell RE, Wilund KR, et al. (2004). Beta2- and beta3-adrenergic receptor polymorphisms and exercise hemodynamics in postmenopausal women. J Appl Physiol 96, 526–530.

Montgomery HE, Clarkson P, Dollery CM, Prasad K, Losi MA, Hemingway H, et al. (1997). Association of angiotensin-converting enzyme gene I/D polymorphism with change in left ventricular mass in response to physical training. Circulation 96, 741–747.

Montgomery HE, Marshall R, Hemingway H, Myerson S, Clarkson P, Dollery C, et al. (1998). Human gene for physical performance. Nature 393, 221–222.

Moore GE, Shuldiner AR, Zmuda JM, Ferrell RE, McCole SD and Hagberg JM (2001). Obesity gene variant and elite endurance performance. Metabolism 50, 1391–1392.

Murgia M, Serrano AL, Calabria E, Pallafacchina G, Lomo T and Schiaffino S (2000). Ras is involved in nerve-activity-dependent regulation of muscle genes. Nat Cell Biol 2, 142–147.

Parsons SA, Wilkins BJ, Bueno OF and Molkentin JD (2003). Altered skeletal muscle phenotypes in calcineurin Aalpha and Abeta gene-targeted mice. Mol Cell Biol 23, 4331–4343.

Parsons SA, Millay DP, Wilkins BJ, Bueno OF, Tsika GL, Neilson JR, et al. (2004). Genetic loss of calcineurin blocks mechanical overload-induced skeletal muscle fiber-type switching but not hypertrophy. J Biol Chem 279, 26192–26200.

Prior SJ, Hagberg JM, Phares DA, Brown MD, Fairfull L, Ferrell RE, et al. (2003). Sequence variation in hypoxia-inducible factor 1alpha (HIF1A): association with maximal oxygen consumption. Physiol Genomics 15, 20–26.

Prior SJ, Hagberg JM, Paton CM, Douglass LW, Brown MD, McLenithan JC, et al. (2006). DNA sequence variation in the promoter region of the VEGF gene impacts VEGF gene expression and maximal oxygen consumption. Am J Physiol Heart Circ Physiol 290, H1848–H1855.

Quiat D, Voelker KA, Pei J, Grishin NV, Grange RW, Bassel-Duby R and Olson EN (2011). Concerted regulation of myofiber-specific gene expression and muscle performance by the transcriptional repressor Sox6. Proc Natl Acad Sci U S A 108, 10196–10201.

Rankinen T, Perusse L, Gagnon J, Chagnon YC, Leon AS, Skinner JS, et al. (2000a). Angiotensinconverting enzyme ID polymorphism and fitness phenotype in the HERITAGE Family Study. J Appl Physiol 88, 1029–1035.

Rankinen T, Wolfarth B, Simoneau JA, Maier-Lenz D, Rauramaa R, Rivera MA, et al. (2000b). No association between the angiotensin-converting enzyme ID polymorphism and elite endurance athlete status. J Appl Physiol 88, 1571–1575.

Rico-Sanz J, Rankinen T, Joanisse DR, Leon AS, Skinner JS, Wilmore JH, et al. (2003). Associations between cardiorespiratory responses to exercise and the C34T AMPD1 gene polymorphism in the HERITAGE Family Study. Physiol Genomics 14, 161–166.

Rigat B, Hubert C, Ahenc-Gelas F, Cambien F, Corvol P and Soubrier F (1990). An insertion/deletion polymorphism in the angiotensin I-converting enzyme gene accounting for half the variance of serum enzyme levels. J Clin Invest 86, 1343–1346.

Rivera MA, Dionne FT, Simoneau JA, Perusse L, Chagnon M, Chagnon Y, et al. (1997). Musclespecific creatine kinase gene polymorphism and V. O 2max in the HERITAGE Family Study. Med Sci Sports Exerc 29, 1311–1317.

Roth SM (2008). Perspective on the future use of genomics in exercise prescription. J Appl Physiol 104, 1243–1245.

Saunders CJ, Xenophontos SL, Cariolou MA, Anastassiades LC, Noakes TD and Collins M (2006). The bradykinin beta 2 receptor (BDKRB2) and endothelial nitric oxide synthase 3 (NOS3) genes and endurance performance during Ironman Triathlons. Hum Mol Genet 15, 979–987.

Scott RA, Fuku N, Onywera VO, Boit M, Wilson RH, Tanaka M, et al. (2009). Mitochondrial haplogroups associated with elite Kenyan athlete status. Med Sci Sports Exerc 41, 123–128.

Shriver MD and Kittles RA (2004). Genetic ancestry and the search for personalized genetic histories. Nat Rev Genet 5, 611–618.

Simoneau JA and Bouchard C (1995). Genetic determinism of fiber type proportion in human skeletal muscle. FASEB J 9, 1091–1095.

Smerdu V, Karsch-Mizrachi I, Campione M, Leinwand L and Schiaffino S (1994). Type IIx myosin heavy chain transcripts are expressed in type IIb fibers of human skeletal muscle. Am J Physiol 267, C1723–C1728.

Timmons JA, Knudsen S, Rankinen T, Koch LG, Sarzynski M, Jensen T, et al. (2010). Using molecular classification to predict gains in maximal aerobic capacity following endurance exercise training in humans. J Appl Physiol 108, 1487–1496.

van Oven M and Kayser M (2009). Updated comprehensive phylogenetic tree of global human mitochondrial DNA variation. Hum Mutat 30, E386–E394.

van Rooij E., Quiat D, Johnson BA, Sutherland LB, Qi X, Richardson JA, et al. (2009). A family of microRNAs encoded by myosin genes governs myosin expression and muscle performance. Dev Cell 17, 662–673.

Wagoner LE, Craft LL, Zengel P, McGuire N, Rathz DA, Dorn GW and Liggett SB (2002). Poly morphisms of the beta1-adrenergic receptor predict exercise capacity in heart failure. Am Heart J 144, 840–846.

Wang YX, Zhang CL, Yu RT, Cho HK, Nelson MC, Bayuga-Ocampo CR, et al. (2004). Regulation of muscle fiber type and running endurance by PPARdelta. PLoS Biol 2, e294.

Wheeler DA, Srinivasan M, Egholm M, Shen Y, Chen L, McGuire A, et al. (2008). The complete genome of an individual by massively parallel DNA sequencing. Nature 452, 872–876.

Williams AG and Folland JP (2008). Similarity of polygenic profiles limits the potential for elite human physical performance. J Physiol 586, 113–121.

Williams AG, Dhamrait SS, Wootton PT, Day SH, Hawe E, Payne JR, et al. (2004). Bradykinin receptor gene variant and human physical performance. J Appl Physiol 96, 938–942.

Wisloff U, Najjar SM, Ellingsen O, Haram PM, Swoap S, Al Share Q, et al. (2005). Cardiovascular risk factors emerge after artificial selection for low aerobic capacity. Science 307, 418–420.

Wolfarth B, Rankinen T, Muhlbauer S, Scherr J, Boulay MR, Perusse L, et al. (2007). Association between a beta2-adrenergic receptor polymorphism and elite endurance performance. Metabolism 56, 1649–1651.

■ جهت مطالعه بیشتر

Egan B and Zierath JR (2013). Exercise metabolism and the molecular regulation of skeletal muscle adaptation. Cell Metab 17, 162–184.

■ منابع

ACSM (2009). American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Med Sci Sports Exerc 41, 687–708.

Allen DL, Roy RR, and Edgerton VR (1999). Myonuclear domains in muscle adaptation and disease. Muscle Nerve 22, 1350–1360.

Amthor H, Otto A, Vulin A, Rochat A, Dumonceaux J, Garcia L, et al. (2009). Muscle hypertrophy driven by myostatin blockade does not require stem/precursor-cell activity. Proc Natl Acad Sci U S A 106, 7479–7484.

Arnold HH and Braun T (1996). Targeted inactivation of myogenic factor genes reveals their role during mouse myogenesis: a review. Int J Dev Biol 40, 345–353.

Baar K and Esser K (1999). Phosphorylation of p70 (S6k) correlates with increased skeletal muscle mass following resistance exercise. Am J Physiol 276, C120–C127.

Bentzinger CF, von Maltzahn J and Rudnicki MA (2010). Extrinsic regulation of satellite cell specifi- cation. Stem Cell Res her 1, 27.

Blaauw B, Canato M, Agatea L, Toniolo L, Mammucari C, Masiero E, et al. (2009). Inducible activa- tion of Akt increases skeletal muscle mass and force without satellite cell activation. FASEB J 23, 3896–3905.

Bodine SC, Stitt TN, Gonzalez M, Kline WO, Stover GL, Bauerlein R, et al. (2001). Akt/mTOR pathway is a crucial regulator of skeletal muscle hypertrophy and can prevent muscle atrophy in vivo. Nat Cell Biol 3, 1014–1019.

Bohe J, Low JF, Wolfe RR and Rennie MJ (2001). Latency and duration of stimulation of human muscle protein synthesis during continuous infusion of amino acids. J Physiol 532, 575–579.

Cao Y, Yao Z, Sarkar D, Lawrence M, Sanchez GJ, Parker MH, et al. (2010). Genome-wide MyoD binding in skeletal muscle cells: a potential for broad cellular reprogramming. Dev Cell 18, 662–674.

Carpinelli RN (2009). Challenging the American College of Sports Medicine 2009 position stand on resistance training. Medicina Sportiva 13, 131–137.

Carpinelli RF, Otto RM and Winett RA (2004). A critical analysis of the ACSM position stand on resistancetraining: Insufficient evidence to support recommended training protocols. J Exerc Physiol 7, 1–60.

Carroll CC, Carrithers JA and Trappe TA (2004). Contractile protein concentrations in human single muscle fibers. J

Muscle Res Cell Motil 25, 55–59.
Coleman ME, DeMayo F, Yin KC, Lee HM, Geske R, Montgomery C, et al. (1995). Myogenic vec- tor expression of insulin-like growth factor I stimulates muscle cell differentiation and myofiber hypertrophy in transgenic mice. J Biol Chem 270, 12109–12116.
Collins CA, Olsen I, Zammit PS, Heslop L, Petrie A, Partridge TA, et al. (2005). Stem cell function, self-renewal, and behavioral heterogeneity of cells from the adult muscle satellite cell niche. Cell 122, 289–301.
Conboy IM and Rando TA (2002). The regulation of Notch signaling controls satellite cell activation and cell fate determination in postnatal myogenesis. Dev Cell 3, 397–409.
Davies SP, Reddy H, Caivano M and Cohen P (2000). Specificity and mechanism of action of some commonly used protein kinase inhibitors. Biochem J 351, 95–105.
Davis RL, Weintraub H and Lassar AB (1987). Expression of a single transfected cDNA converts fibroblasts to myoblasts. Cell 51, 987–1000.
Drummond MJ, Fry CS, Glynn EL, Dreyer HC, Dhanani S, Timmerman KL, et al. (2009). Rapamy- cin administration in humans blocks the contraction-induced increase in skeletal muscle protein synthesis. J Physiol 587, 1535–1546.
Edmondson DG and Olson EN (1989). A gene with homology to the myc similarity region of MyoD1 is expressed during myogenesis and is sufficient to activate the muscle differentiation program. Genes Dev 3, 628–640.
Ferrari G, Cusella-De Angelis G, Coletta M, Paolucci E, Stornaiuolo A, Cossu G, et al. (1998). Muscle regeneration by bone marrow-derived myogenic progenitors. Science 279, 1528–1530.
Forsberg AM, Nilsson E, Werneman J, Bergstrom J and Hultman E (1991). Muscle composition in relation to age and sex. Clin Sci (Lond) 81, 249–256.
Goodman CA, Miu MH, Frey JW, Mabrey DM, Lincoln HC, Ge Y, et al. (2010). A phosphatidylino- sitol 3-kinase/protein kinase B-independent activation of mammalian target of rapamycin signal- ing is sufficient to induce skeletal muscle hypertrophy. Mol Biol Cell 21, 3258–3268.
Goodman CA, Frey JW, Mabrey DM, Jacobs BL, Lincoln HC, You JS, et al. (2011). The role of skeletal muscle mTOR in the regulation of mechanical load-induced growth. J Physiol 589, 5485–5501.
Heron MI and Richmond FJ (1993). In-series fiber architecture in long human muscles. J Morphol 216, 35–45.
Holz MK, Ballif BA, Gygi SP and Blenis J (2005). mTOR and S6K1 mediate assembly of the translation preinitiation complex through dynamic protein interchange and ordered phosphorylation events. Cell 123, 569–580
Hornberger TA (2011). Mechanotransduction and the regulation of mTORC1 signaling in skeletal muscle. Int J Biochem Cell Biol 43, 1267–1276.
Hubal MJ, Gordish-Dressman H, hompson PD, Price TB, Hoffman EP, Angelopoulos TJ, et al. (2005). Variability in muscle size and strength gain after unilateral resistance training. Med Sci Sports Exerc 37, 964–972.
Inoki K, Zhu T and Guan KL (2003). TSC2 mediates cellular energy response to control cell growth and survival. Cell 115, 577–590.
Janssen I, Heymsfield SB, Wang ZM and Ross R (2000). Skeletal muscle mass and distribution in 468 men and women aged 18–88 yr. J Appl Physiol 89, 81–88.
Judson RN, Tremblay AM, Knopp P, White RB, Urcia R, De BC, et al. (2012). The Hippo pathway member Yap plays a key role in influencing fate decisions in muscle satellite cells. J Cell Sci 125, 6009–6019.
Kadi F, Charifi N, Denis C, Lexell J, Andersen JL, Schjerling P, et al. (2005). The behaviour of sat- ellite cells in response to exercise: what have we learned from human studies? Pflugers Arch 451, 319–327.
Katz B (1961). The terminations of the afferent nerve fibre in the muscle spindle of the frog. Philos Trans R Soc Lond B Biol Sci 243, 221–240.
Kelley G (1996). Mechanical overload and skeletal muscle fiber hyperplasia: a meta-analysis. J Appl Physiol 81, 1584–1588.
Kim E and Guan KL (2009). RAG GTPases in nutrient-mediated TOR signaling pathway. Cell Cycle 8, 1014–1018.
Kim PL, Staron RS and Phillips SM (2005). Fasted-state skeletal muscle protein synthesis after resist- ance exercise is altered with training. J Physiol 568, 283–290.
Kim JS, Petrella JK, Cross JM and Bamman MM (2007). Load-mediated downregulation of myosta- tin mRNA is not sufficient to promote myofiber hypertrophy in humans: a cluster analysis. J Appl Physiol 103, 1488–1495.
Kraemer WJ, Adams K, Cafarelli E, Dudley GA, Dooly C, Feigenbaum MS, et al. (2002). American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Med Sci Sports Exerc 34, 364–380.
Lai KM, Gonzalez M, Poueymirou WT, Kline WO, Na E, Zlotchenko E, et al. (2004). Conditional activation of akt in adult skeletal muscle induces rapid hypertrophy. Mol Cell Biol 24, 9295–9304.
Lassar AB, Paterson BM and Weintraub H (1986). Transfection of a DNA locus that mediates the conversion of 10T1/2 fibroblasts to myoblasts. Cell 47, 649–656.
Lee SJ (2004). Regulation of muscle mass by myostatin. Annu Rev Cell Dev Biol 20, 61–86. Lee SJ (2007). Quadrupling

muscle mass in mice by targeting TGF-beta signaling pathways. PLoS ONE 2, e789.

Lee SJ (2010). Extracellular regulation of myostatin: a molecular rheostat for muscle mass. Immunol Endocr Metab Agents Med Chem 10, 183–194. Lepper C, Partridge TA and Fan CM (2011). An absolute requirement for Pax7-positive satellite cells in acute injury-induced skeletal muscle regeneration. Development 138, 3639–3646.

Lexell J, Taylor CC and Sjostrom M (1988). What is the cause of the ageing atrophy? Total number, size and proportion of different fiber types studied in whole vastus lateralis muscle from 15- to 83-year-old men. J Neurol Sci 84, 275–294.

Louis E, Raue U, Yang Y, Jemiolo B and Trappe S (2007). Time course of proteolytic, cytokine, and myostatin gene expression after acute exercise in human skeletal muscle. J Appl Physiol 103, 1744–1751.

Mauro A (1961). Satellite cell of skeletal muscle fibers. J Biophys Biochem Cytol 9, 493–495.

McCarthy JJ, Mula J, Miyazaki M, Erfani R, Garrison K, Farooqui AB, et al. (2011). Effective fiber hypertrophy in satellite cell-depleted skeletal muscle. Development 138, 3657–3666.

McCroskery S, homas M, Maxwell L, Sharma M and Kambadur R (2003). Myostatin negatively regulates satellite cell activation and self-renewal. J Cell Biol 162, 1135–1147.

McPherron AC, Lawler AM and Lee SJ (1997). Regulation of skeletal muscle mass in mice by a new TGF-beta superfamily member. Nature 387, 83–90.

Mendias CL, Marcin JE, Calerdon DR and Faulkner JA (2006). Contractile properties of EDL and soleus muscles of myostatin-deficient mice. J Appl Physiol 101, 898–905.

Miller BF, Olesen JL, Hansen M, Dossing S, Crameri RM, Welling RJ, et al. (2005). Coordinated col- lagen and muscle protein synthesis in human patella tendon and quadriceps muscle after exercise. J Physiol 567, 1021–1033.

Mosher DS, Quignon P, Bustamante CD, Sutter NB, Mellersh CS, Parker HG, et al. (2007). A muta- tion in the myostatin gene increases muscle mass and enhances racing performance in heterozygote dogs. PLoS Genet 3, e79.

Mourikis P, Sambasivan R, Castel D, Rocheteau P, Bizzarro V and Tajbakhsh S (2012). A critical requirement for notch signaling in maintenance of the quiescent skeletal muscle stem cell state. Stem Cells 30, 243–252.

O'Connor RS and Pavlath GK (2007). Point: Counterpoint: Satellite cell addition is/is not obligatory for skeletal muscle hypertrophy. J Appl Physiol 103, 1099–1100.

Ono Y, Calhabeu F, Morgan JE, Katagiri T, Amthor H and Zammit PS (2011). BMP signalling per- mits population expansion by preventing premature myogenic differentiation in muscle satellite cells. Cell Death Differ 18, 222–234.

Otto A, Schmidt C, Luke G, Allen S, Valasek P, Muntoni F, et al. (2008). Canonical Wnt signal- ling induces satellite-cell proliferation during adult skeletal muscle regeneration. J Cell Sci 121, 2939–2950.

Otto A, Collins-Hooper H, Patel A, Dash PR and Patel K (2011). Adult skeletal muscle stem cell migration is mediated by a blebbing/amoeboid mechanism. Rejuvenation Res 14, 249–260.

Pallafacchina G, Calabria E, Serrano AL, Kalhovde JM and Schiaffino S (2002). A protein kinase B-dependent and rapamycin-sensitive pathway controls skeletal muscle growth but not fiber type specification. Proc Natl Acad Sci U S A 99, 9213–9218.

Phillips SM, Tipton KD, Aarsland A, Wolf SE and Wolfe RR (1997). Mixed muscle protein synthesis and breakdown after resistance exercise in humans. Am J Physiol 273, E99–107.

Philp A, Hamilton DL and Baar K (2011). Signals mediating skeletal muscle remodeling by resistance exercise: PI3-kinase independent activation of mTORC1. J Appl Physiol 110, 561–568.

Rosenblatt JD and Parry DJ (1992). Gamma irradiation prevents compensatory hypertrophy of over- loaded mouse extensor digitorum longus muscle. J Appl Physiol 73, 2538–2543.

Sacco A, Doyonnas R, Kraft P, Vitorovic S and Blau HM (2008). Self-renewal and expansion of single transplanted muscle stem cells. Nature 456, 502–506.

Sale DG (1988). Neural adaptation to resistance training. Med Sci Sports Exerc 20, S135–S145.

Scharner J and Zammit PS (2011). The muscle satellite cell at 50: the formative years. Skelet Muscle 1, 28.

Schuelke M, Wagner KR, Stolz LE, Hubner C, Riebel T, Komen W, et al. (2004). Myostatin muta- tion associated with gross muscle hypertrophy in a child. N Engl J Med 350, 2682–2688.

Seale P, Sabourin LA, Girgis-Gabardo A, Mansouri A, Gruss P and Rudnicki MA (2000). Pax7 is required for the specification of myogenic satellite cells. Cell 102, 777–786.

Sherwood RI, Christensen JL, Conboy IM, Conboy MJ, Rando TA, Weissman IL, et al. (2004). Isola- tion of adult mouse myogenic progenitors: functional heterogeneity of cells within and engrafting skeletal muscle. Cell 119, 543–554.

Spangenburg EE, Le RD, Ward CW and Bodine SC (2008). A functional insulin-like growth factor receptor is not necessary for load-induced skeletal muscle hypertrophy. J Physiol 586, 283–291.

Studitsky AN (1964). Free auto- and homografts of muscle tissue in experiments on animals. Ann N Y Acad Sci 120, 789–801.

Sutrave P, Kelly AM and Hughes SH (1990). Ski can cause selective growth of skeletal muscle in trans- genic mice. Genes Dev 4, 1462–1472.

Tipton KD, Ferrando AA, Phillips SM, Doyle D, Jr. and Wolfe RR (1999). Postexercise net pro-

tein synthesis in human muscle from orally administered amino acids. Am J Physiol 276, E628–E634.
Tseng BS, Kasper CE and Edgerton VR (1994). Cytoplasm-to-myonucleus ratios and succinate dehy- drogenase activities in adult rat slow and fast muscle fibers. Cell Tissue Res 275, 39–49.
Van CM, Duchateau J and Hainaut K (1998). Changes in single motor unit behaviour contribute to the increase in contraction speed after dynamic training in humans. J Physiol 513 Pt 1, 295–305.
Weintraub H, Tapscott SJ, Davis RL, hayer MJ, Adam MA, Lassar AB, et al. (1989). Activation of muscle-specific genes in pigment, nerve, fat, liver, and fibroblast cell lines by forced expression of MyoD. Proc Natl Acad Sci U S A 86, 5434–5438.
Welle S, Bhatt K and Pinkert CA (2006). Myofibrillar protein synthesis in myostatin-deficient mice. Am J Physiol Endocrinol Metab 290, E409–E415.
Welle S, Bhatt K, Pinkert CA, Tawil R and hornton CA (2007). Muscle growth after postdevelop- mental myostatin gene knockout. Am J Physiol Endocrinol Metab 292, E985–E991.
Welle S, Mehta S and Burgess K (2011). Effect of postdevelopmental myostatin depletion on myofi- brillar protein metabolism. Am J Physiol Endocrinol Metab 300, E993–E1001.
Whittemore LA, Song K, Li X, Aghajanian J, Davies M, Girgenrath S, et al. (2003). Inhibition of myostatin in adult mice increases skeletal muscle mass and strength. Biochem Biophys Res Commun 300, 965–971.
Winbanks CE, Weeks KL, homson RE, Sepulveda PV, Beyer C, Qian H, et al. (2012). Follistatin- mediated skeletal muscle hypertrophy is regulated by Smad3 and mTOR independently of myosta- tin. J Cell Biol 197, 997–1008.
Zammit PS, Golding JP, Nagata Y, Hudon V, Partridge TA and Beauchamp JR (2004). Muscle satel- lite cells adopt divergent fates: a mechanism for self-renewal? J Cell Biol 166, 347–357.

■ جهت مطالعه بیشتر

Bouchard C and Houman EP (2011). Genetic and molecular aspects of sports performance, Vol. 18 of Encyclopedia of sports medicine. John Wiley & Sons, Chichester.
Peeters MW, homis MA, Beunen GP and Malina RM (2009). Genetics and sports: an overview of the pre-molecular biology era. Med Sport Sci 54, 28–42.
Pescatello LS and Roth SM (2011). Exercise genomics Springer, New York.
Schuelke M, Wagner KR, Stolz LE, Hubner C, Riebel T, Komen W, et al. (2004). Myostatin mutation associated with gross muscle hypertrophy in a child. N Engl J Med 350, 2682–2688.
Yang N, MacArthur DG, Gulbin JP, Hahn AG, Beggs AH, et al. (2003). ACTN3 genotype is associated with human elite athletic performance. Am J Hum Genet 73, 627–631.

■ منابع

Alfred T, Ben-Shlomo Y, Cooper R, Hardy R, Cooper C, Deary IJ, et al. (2011). ACTN3 genotype, athletic status, and life course physical capability: meta-analysis of the published literature and findings from nine studies. Hum Mutat 32, 1008–1018.
Amthor H, Macharia R, Navarrete R, Schuelke M, Brown SC, Otto A, et al. (2007). Lack of myostatin results in excessive muscle growth but impaired force generation. Proc Natl Acad Sci U S A 104, 1835–1840.
Binns MM, Boehler DA and Lambert DH (2010). Identification of the myostatin locus (MSTN) as having a major effect on optimum racing distance in the horoughbred horse in the USA. Anim Genet 41 Suppl 2, 154–158.
Bogl LH, Latvala A, Kaprio J, Sovijarvi O, Rissanen A and Pietilainen KH (2011). An investigation into the relationship between soft tissue body composition and bone mineral density in a young adult twin sample. J Bone Miner Res 26, 79–87.
Coleman ME, DeMayo F, Yin KC, Lee HM, Geske R, Montgomery C, et al. (1995). Myogenic vector expression of insulin-like growth factor I stimulates muscle cell differentiation and myofiber hypertrophy in transgenic mice. J Biol Chem 270, 12109–12116.
Dahiya S, Bhatnagar S, Hindi SM, Jiang C, Paul PK, Kuang S and Kumar A (2011). Elevated levels of active matrix metalloproteinase-9 cause hypertrophy in skeletal muscle of normal and dystrophin- deficient mdx mice. Hum Mol

Genet 20, 4345–4359.
De Mars G, Windelinckx A, Huygens W, Peeters MW, Beunen GP, Aerssens J, et al. (2008). Genome-wide linkage scan for maximum and length-dependent knee muscle strength in young men: significant evidence for linkage at chromosome 14q24.3. J Med Genet 45, 275–283.
Delmonico MJ, Kostek MC, Doldo NA, Hand BD, Walsh S, Conway JM, et al. (2007). Alpha- actinin-3 (ACTN3) R577X polymorphism influences knee extensor peak power response to strength training in older men and women. J Gerontol A Biol Sci Med Sci 62, 206–212.
Grundberg E, Brandstrom H, Ribom EL, Ljunggren O, Mallmin H and Kindmark A (2004). Genetic variation in the human vitamin D receptor is associated with muscle strength, fat mass and body weight in Swedish women. Eur J Endocrinol 150, 323–328.
Hall KD (2010). Mathematical modelling of energy expenditure during tissue deposition. Br J Nutr 104, 4–7.
Haq S, Kilter H, Michael A, Tao J, O'Leary E, Sun XM, et al. (2003). Deletion of cytosolic phospholipase A2 promotes striated muscle growth. Nat Med 9, 944–951.
Hsu FC, Lenchik L, Nicklas BJ, Lohman K, Register TC, Mychaleckyj J, et al. (2005). Heritability of body composition measured by DXA in the diabetes heart study. Obes Res 13, 312–319.
Hubal MJ, Gordish-Dressman H, hompson PD, Price TB, Hoffman EP, Angelopoulos TJ, et al. (2005). Variability in muscle size and strength gain after unilateral resistance training. Med Sci Sports Exerc 37, 964–972.
Hughes DC, Day SH, Ahmetov II and Williams AG (2011). Genetics of muscle strength and power: Polygenic profile similarity limits skeletal muscle performance. J Sports Sci 29, 1425–1434.
Huygens W, homis MA, Peeters MW, Aerssens J, Janssen R, Vlietinck RF, et al. (2004a). Linkage of myostatin pathway genes with knee strength in humans. Physiol Genomics 17, 264–270.
Huygens W, homis MA, Peeters MW, Vlietinck RF and Beunen GP (2004b). Determinants and upper-limit heritabilities of skeletal muscle mass and strength. Can J Appl Physiol 29, 186–200.
Huygens W, homis MA, Peeters MW, Aerssens J, Vlietinck R and Beunen GP (2005). Quantitative trait loci for human muscle strength: linkage analysis of myostatin pathway genes. Physiol Genomics 22, 390–397.
Janssen I, Heymsfield SB, Wang ZM and Ross R (2000). Skeletal muscle mass and distribution in 468 men and women aged 18–88 yr. J Appl Physiol 89, 81–88.
Kostek MC, Delmonico MJ, Reichel JB, Roth SM, Douglass L, Ferrell RE, et al. (2005). Muscle strength response to strength training is influenced by insulin-like growth factor 1 genotype in older adults. J Appl Physiol 98, 2147–2154.
Lai KM, Gonzalez M, Poueymirou WT, Kline WO, Na E, Zlotchenko E, et al. (2004). Conditional activation of akt in adult skeletal muscle induces rapid hypertrophy. Mol Cell Biol 24, 9295–9304.
Lee SJ (2007). Quadrupling muscle mass in mice by targeting TGF-beta signaling pathways. PLoS ONE 2, e789.
Lexell J, Taylor CC and Sjostrom M (1988). What is the cause of the ageing atrophy? Total number, size and proportion of different fiber types studied in whole vastus lateralis muscle from 15- to 83-year-old men. J Neurol Sci 84, 275–294.
Lionikas A, Cheng R, Lim JE, Palmer AA and Blizard DA (2010). Fine-mapping of muscle weight QTL in LG/J and SM/J intercrosses. Physiol Genomics 42A, 33–38.
Liu D, Metter EJ, Ferrucci L and Roth SM (2008). TNF promoter polymorphisms associated with muscle phenotypes in humans. J Appl Physiol 105, 859–867.
MacArthur DG, Seto JT, Chan S, Quinlan KG, Raftery JM, Turner N, et al. (2008). An Actn3 knockout mouse provides mechanistic insights into the association between alpha-actinin-3 deficiency and human athletic performance. Hum Mol Genet 17, 1076–1086.
McPherron AC and Lee SJ (1997). Double muscling in cattle due to mutations in the myostatin gene. Proc Natl Acad Sci U S A 94, 12457–12461.
McPherron AC and Lee SJ (2002). Suppression of body fat accumulation in myostatin-deficient mice. J Clin Invest 109, 595–601.
McPherron AC, Lawler AM and Lee SJ (1997). Regulation of skeletal muscle mass in mice by a new TGF-beta superfamily member. Nature 387, 83–90.
Mills M, Yang N, Weinberger R, Vander Woude DL, Beggs AH, Easteal S and North K (2001). Differential expression of the actin-binding proteins, alpha-actinin-2 and -3, in different species: implications for the evolution of functional redundancy. Hum Mol Genet 10, 1335–1346.
Mosher DS, Quignon P, Bustamante CD, Sutter NB, Mellersh CS, Parker HG, et al. (2007). A mutation in the myostatin gene increases muscle mass and enhances racing performance in heterozygote dogs. PLoS Genet 3, e79.

Nimmo MA, Wilson RH and Snow DH (1985). The inheritance of skeletal muscle fibre composition in mice. Comp Biochem Physiol A Comp Physiol 81, 109–115.

North KN, Yang N, Wattanasirichaigoon D, Mills M, Easteal S and Beggs AH (1999). A common nonsense mutation results in alpha-actinin-3 deficiency in the general population. Nat Genet 21, 353–354.

Ohanna M, Sobering AK, Lapointe T, Lorenzo L, Praud C, Petroulakis E, et al. (2005). Atrophy of S6K1(-/-) skeletal muscle cells reveals distinct mTOR effectors for cell cycle and size control. Nat Cell Biol 7, 286–294.

Ontell MP, Sopper MM, Lyons G, Buckingham M and Ontell M (1993). Modulation of contractile protein gene expression in fetal murine crural muscles: emergence of muscle diversity. Dev Dyn 198, 203–213.

Peeters MW, homis MA, Beunen GP and Malina RM (2009). Genetics and sports: an overview of the pre-molecular biology era. Med Sport Sci 54, 28–42.

Proud CG (2004). mTOR-mediated regulation of translation factors by amino acids. Biochem Biophys Res Commun 313, 429–436.

Riechman SE, Balasekaran G, Roth SM and Ferrell RE (2004). Association of interleukin-15 protein and interleukin-15 receptor genetic variation with resistance exercise training responses. J Appl Physiol 97, 2214–2219.

Roth SM, Schrager MA, Ferrell RE, Riechman SE, Metter EJ, Lynch NA, et al. (2001). CNTF genotype is associated with muscular strength and quality in humans across the adult age span. J Appl Physiol 90, 1205–1210.

Santiago C, Ruiz JR, Rodriguez-Romo G, Fiuza-Luces C, Yvert T, Gonzalez-Freire M, et al. (2011). The K153R polymorphism in the myostatin gene and muscle power phenotypes in young, non- athletic men. PLoS ONE 6, e16323.

Sayer AA, Syddall H, O'Dell SD, Chen XH, Briggs PJ, Briggs R, et al. (2002). Polymorphism of the IGF2 gene, birth weight and grip strength in adult men. Age Ageing 31, 468–470.

Schrager MA, Roth SM, Ferrell RE, Metter EJ, Russek-Cohen E, Lynch NA, et al. (2004). Insulin-like growth factor-2 genotype, fat-free mass, and muscle performance across the adult life span. J Appl Physiol 97, 2176–2183.

Schuelke M, Wagner KR, Stolz LE, Hubner C, Riebel T, Komen W, et al. (2004). Myostatin mutation associated with gross muscle hypertrophy in a child. N Engl J Med 350, 2682–2688.

Seale P, Sabourin LA, Girgis-Gabardo A, Mansouri A, Gruss P and Rudnicki MA (2000). Pax7 is required for the specification of myogenic satellite cells. Cell 102, 777–786.

Silventoinen K, Magnusson PK, Tynelius P, Kaprio J and Rasmussen F (2008). Heritability of body size and muscle strength in young adulthood: a study of one million Swedish men. Genet Epidemiol 32, 341–349.

Smerdu V, Karsch-Mizrachi I, Campione M, Leinwand L and Schiaffino S (1994). Type IIx myosin heavy chain transcripts are expressed in type IIb fibers of human skeletal muscle. Am J Physiol 267, C1723–C1728.

Souren NY, Paulussen AD, Loos RJ, Gielen M, Beunen G, Fagard R, et al. (2007). Anthropometry, carbohydrate and lipid metabolism in the East Flanders Prospective Twin Survey: heritabilities. Diabetologia 50, 2107–2116.

Sutrave P, Kelly AM and Hughes SH (1990). ski can cause selective growth of skeletal muscle in transgenic mice. Genes Dev 4, 1462–1472.

Totsuka Y, Nagao Y, Horii T, Yonekawa H, Imai H, Hatta H, et al. (2003). Physical performance and soleus muscle fiber composition in wild-derived and laboratory inbred mouse strains. J Appl Physiol 95, 720–727.

Vincent B, De Bock K, Ramaekers M, Van den Eede E, Van Leemputte M, Hespel P, et al. (2007). ACTN3 (R577X) genotype is associated with fiber type distribution. Physiol Genomics 32, 58–63.

Wang P, Ma LH, Wang HY, Zhang W, Tian Q, Cao DN, Zheng GX and Sun YL (2006). Association between polymorphisms of vitamin D receptor gene ApaI, BsmI and TaqI and muscular strength in young Chinese women. Int J Sports Med 27, 182–186.

Welle S, Mehta S and Burgess K (2011). Effect of postdevelopmental myostatin depletion on myofibrillar protein metabolism. Am J Physiol Endocrinol Metab 300, E993–E1001.

Wheeler DA, Srinivasan M, Egholm M, Shen Y, Chen L, McGuire A, et al. (2008). The complete genome of an individual by massively parallel DNA sequencing. Nature 452, 872–876.

Whittemore LA, Song K, Li X, Aghajanian J, Davies M, Girgenrath S, et al. (2003). Inhibition of myostatin in adult mice increases skeletal muscle mass and strength. Biochem Biophys Res Commun 300, 965–971.

Windelinckx A, De Mars G, Huygens W, Peeters MW, Vincent B, Wijmenga C, et al. (2011). Comprehensive fine mapping of chr12q12–14 and follow-up replication identify activin receptor 1B (ACVR1B) as a muscle strength gene. Eur J Hum Genet 19, 208–215.

Yang N, MacArthur DG, Gulbin JP, Hahn AG, Beggs AH, Easteal S, and North K (2003). ACTN3 genotype is associated with human elite athletic performance. Am J Hum Genet 73, 627–631.

■ جهت مطالعه بیشتر

Atherton PJ and Smith K (2012). Muscle protein synthesis in response to nutrition and exercise. J Physiol 590, 1049–1057.

Bilan PJ, Samokhvalov V, Koshkina A, Schertzer JD, Samaan MC and Klip A (2009). Direct and macrophage-mediated actions of fatty acids causing insulin resistance in muscle cells. Arch Physiol Biochem 115, 176–190.

Gallen IW, Hume C and Lumb A (2011). Fuelling the athlete with type 1 diabetes. Diabetes Obes Metab 13, 130–136.

Cummings DE and Overduin J (2007). Gastrointestinal regulation of food intake. J Clin Invest 117, 13–23.

Hawley JA, Schabort EJ, Noakes TD and Dennis SC (1997). Carbohydrate-loading and exercise performance. An update. Sports Med 24, 73–81.

Philp A, Hargreaves M and Baar K (2012). More than a store: regulatory roles for glycogen in skeletal muscle adaptation to exercise. Am J Physiol Endocrinol Metab 302, E1343–E1351.

Watt MJ and Hoy AJ (2012). Lipid metabolism in skeletal muscle: generation of adaptive and maladaptive intracellular signals for cellular function. Am J Physiol Endocrinol Metab 302, E1315–E1328.

■ منابع

Al MO, Pardo M, Roca-Rivada A, Castelao C, Casanueva FF and Seoane LM (2010b). Macronutrients act directly on the stomach to regulate gastric ghrelin release. J Endocrinol Invest 33, 599–602.

Allirot X, Saulais L, Seyssel K, Graeppi-Dulac J, Roth H, Charrie A, et al. (2013b). An isocaloric increase of eating episodes in the morning contributes to decrease energy intake at lunch in lean men. Physiol Behav 110–111, 169–178.

Andrali SS, Sampley ML, Vanderford NL and Ozcan S (2008). Glucose regulation of insulin gene expression in pancreatic beta-cells. Biochem J 415, 1–10.

Andre C and Cota D (2012). Coupling nutrient sensing to metabolic homoeostasis: the role of the mammalian target of rapamycin complex 1 pathway. Proc Nutr Soc 71, 502–510.

Areta JL, Burke LM, Ross ML, Camera DM, West DW, Broad EM, et al. (2013b). Timing and distribution of protein ingestion during prolonged recovery from resistance exercise alters myofibrillar protein synthesis. J Physiol 591, 2319–2331.

Ashford M, Beall C and McCrimmon R (2012). Hypoglycaemia: exercise for the brain? J Neuroendocrinol 24, 1365–1366.

Banks WA, Coon AB, Robinson SM, Moinuddin A, Shultz JM, Nakaoke R, et al. (2004). Triglycerides induce leptin resistance at the blood–brain barrier. Diabetes 53, 1253–1260.

Bansal P and Wang Q (2008a). Insulin as a physiological modulator of glucagon secretion. Am J Physiol Endocrinol Metab 295, E751–E761.

Batterham RL and Bloom SR (2003a). THe gut hormone peptide YY regulates appetite. Ann N Y Acad Sci 994, 162–168.

Beall C, Ashford ML and McCrimmon RJ (2012a). The physiology and pathophysiology of the neural control of the counterregulatory response. Am J Physiol Regul Integr Comp Physiol 302, R215–R223.

Beelen M, Berghuis J, Bonaparte B, Ballak SB, Jeukendrup AE and van Loon LJ (2009). Carbohydrate mouth rinsing in the fed state: lack of enhancement of time-trial performance. Int J Sport Nutr Exerc Metab 19, 400–409.

Bergstrom J and Hultman E (1966). Muscle glycogen synthesis after exercise: an enhancing factor localized to the muscle cells in man. Nature 210, 309–310.

Bergstrom J and Hultman E (1967). A study of the glycogen metabolism during exercise in man. Scand J Clin Lab Invest 19, 218–228.

Bjorbaek C, Elmquist JK, Frantz JD, Shoelson SE and Flier JS (1998). Identification of SOCS-3 as a potential mediator of central leptin resistance. Mol Cell 1, 619–625.

Blundell JE (2006). Perspective on the central control of appetite. Obesity (Silver Spring) 14 Suppl 4, 160S–163S.

Bohe J, Low JF, Wolfe RR and Rennie MJ (2001). Latency and duration of stimulation of human muscle protein synthesis during continuous infusion of amino acids. J Physiol 532, 575–579.

Bohe J, Low A, Wolfe RR and Rennie MJ (2003). Human muscle protein synthesis is modulated by extracellular, not intramuscular amino acid availability: a dose-response study. J Physiol 552, 315–324.

Boirie Y, Dangin M, Gachon P, Vasson MP, Maubois JL and Beaufrere B (1997). Slow and fast dietary proteins differently modulate postprandial protein accretion. Proc Natl Acad Sci U S A 94, 14930–14935.

Brazeau AS, Rabasa-Lhoret R, Strychar I and Mircescu H (2008). Barriers to physical activity among patients with type 1 diabetes. Diabetes Care 31, 2108–2109.

Burke LM, Millet G and Tarnopolsky MA (2007). Nutrition for distance events. J Sports Sci 25 Suppl 1, S29–S38.
Chambers ES, Bridge MW and Jones DA (2009). Carbohydrate sensing in the human mouth: effects on exercise performance and brain activity. J Physiol 587, 1779–1794.
Chen K, Li F, Li J, Cai H, Strom S, Bisello A, et al. (2006). Induction of leptin resistance through direct interaction of C-reactive protein with leptin. Nat Med 12, 425–432.
Christie GR, Hajduch E, Hundal HS, Proud CG and Taylor PM (2002). Intracellular sensing of amino acids in Xenopus laevis oocytes stimulates p70 S6 kinase in a target of rapamycin-dependent manner. J Biol Chem 277, 9952–9957.
Churchward-Venne TA, Burd NA and Phillips SM (2012). Nutritional regulation of muscle protein synthesis with resistance exercise: strategies to enhance anabolism. Nutr Metab (Lond) 9, 40. Crozier SJ, Kimball SR, Emmert SW, Anthony JC and Jefferson LS (2005). Oral leucine administration stimulates protein synthesis in rat skeletal muscle. J Nutr 135, 376–382.
Cryer PE (2005). Mechanisms of hypoglycemia-associated autonomic failure and its component syndromes in diabetes. Diabetes 54, 3592–3601.
Cryer PE (2008). Hypoglycemia: still the limiting factor in the glycemic management of diabetes. Endocr Pract 14, 750–756.
Cryer PE (2009). Exercise-related hypoglycemia-associated autonomic failure in diabetes. Diabetes 58, 1951–1952.
Cummings DE and Overduin J (2007). Gastrointestinal regulation of food intake. J Clin Invest 117, 13–23.
Cuthbertson D, Smith K, Babraj J, Leese G, Waddell T, Atherton P, et al. (2005). Anabolic signaling deficits underlie amino acid resistance of wasting, aging muscle. FASEB J 19, 422–424.
D'Alessio DA, Kahn SE, Leusner CR and Ensinck JW (1994). Glucagon-like peptide 1 enhances glucose tolerance both by stimulation of insulin release and by increasing insulin-independent glucose disposal. J Clin Invest 93, 2263–2266.
Dickinson JM, Fry CS, Drummond MJ, Gundermann DM, Walker DK, Glynn EL, et al. (2011). Mammalian target of rapamycin complex 1 activation is required for the stimulation of human skeletal muscle protein synthesis by essential amino acids. J Nutr 141, 856–862.
Dodd KM and Tee AR (2012). Leucine and mTORC1: a complex relationship. Am J Physiol Endocrinol Metab 302, E1329–E1342.
Drummond MJ, Dickinson JM, Fry CS, Walker DK, Gundermann DM, Reidy PT, et al. (2012). Bed rest impairs skeletal muscle amino acid transporter expression, mTORC1 signaling, and protein synthesis in response to essential amino acids in older adults. Am J Physiol Endocrinol Metab 302, E1113–E1122.
Fares EJ and Kayser B (2011). Carbohydrate mouth rinse effects on exercise capacity in pre- and postprandial states. J Nutr Metab 2011, 385962.
Friedman JM and Halaas JL (1998). Leptin and the regulation of body weight in mammals. Nature 395, 763–770.
Galassetti P, Tate D, Neill RA, Richardson A, Leu SY and Davis SN (2006). Effect of differing antecedent hypoglycemia on counterregulatory responses to exercise in type 1 diabetes. Am J Physiol Endocrinol Metab 290, E1109–E1117.
Gallen IW, Hume C and Lumb A (2011). Fuelling the athlete with type 1 diabetes. Diabetes Obes Metab 13, 130–136.
Gant N, Stinear CM and Byblow WD (2010). Carbohydrate in the mouth immediately facilitates motor output. Brain Res 1350, 151–158.
Hawley JA, Schabort EJ, Noakes TD and Dennis SC (1997). Carbohydrate-loading and exercise performance. An update. Sports Med 24, 73–81.
Hawley JA, Burke LM, Phillips SM and Spriet LL (2011). Nutritional modulation of training-induced skeletal muscle adaptations. J Appl Physiol 110, 834–845.
Henquin JC (2009). Regulation of insulin secretion: a matter of phase control and amplitude modulation. Diabetologia 52, 739–751.
Holloszy JO (2005). Exercise-induced increase in muscle insulin sensitivity. J Appl Physiol 99, 338–343.
Holst JJ (2007). the physiology of glucagon-like peptide 1. Physiol Rev 87, 1409–1439.
Hyde R, Peyrollier K and Hundal HS (2002). Insulin promotes the cell surface recruitment of the SAT2/ATA2 system A amino acid transporter from an endosomal compartment in skeletal muscle cells. J Biol Chem 277, 13628–13634.
Jewell JL, Russell RC and Guan KL (2013). Amino acid signalling upstream of mTOR. Nat Rev Mol Cell Biol 14, 133–139.
Jiang G and Zhang BB (2003). Glucagon and regulation of glucose metabolism. Am J Physiol Endocrinol Metab 284, E671-E678.
Jordan SD, Konner AC and Bruning JC (2010). Sensing the fuels: glucose and lipid signaling in the CNS controlling energy homeostasis. Cell Mol Life Sci 67, 3255–3273.
Jorpes E, Mutt V and Olbe L (1959). On the biological assay of cholecystokinin and its dosage in cholecystography. Acta Physiol Scand 47, 109–114.
Kim E and Guan KL (2009). RAG GTPases in nutrient-mediated TOR signaling pathway. Cell Cycle 8, 1014–1018.

Kimball SR and Jefferson LS (2005). Role of amino acids in the translational control of protein synthesis in mammals. Semin Cell Dev Biol 16, 21–27.
Kissileff HR, Carretta JC, Geliebter A and Pi-Sunyer FX (2003b). Cholecystokinin and stomach distension combine to reduce food intake in humans. Am J Physiol Regul Integr Comp Physiol 285, R992–R998.
Kristensen M and Jensen MG (2011). Dietary fibres in the regulation of appetite and food intake. Importance of viscosity. Appetite 56, 65–70.
Lane SC, Bird SR, Burke LM and Hawley JA (2013). Effect of a carbohydrate mouth rinse on simulated cycling time-trial performance commenced in a fed or fasted state. Appl Physiol Nutr Metab 38, 134–139.
Lewis LD and Williams JA (1990). Regulation of cholecystokinin secretion by food, hormones, and neural pathways in the rat. Am J Physiol 258, G512–G518.
Luyckx AS and Lefebvre PJ (1974). Mechanisms involved in the exercise-induced increase in glucagon secretion in rats. Diabetes 23, 81–93.
Lyly M, Ohls N, Lahteenmaki L, Salmenkallio-Marttila M, Liukkonen KH, Karhunen L, et al. (2010). The effect of fibre amount, energy level and viscosity of beverages containing oat fibre supplement on perceived satiety. Food Nutr Res 54. Mangelsdorf DJ and Evans RM (1995). The RXR heterodimers and orphan receptors. Cell 83, 841–850.
Massa ML, Gagliardino JJ and Francini F (2011). Liver glucokinase: An overview on the regulatory mechanisms of its activity. IUBMB Life 63, 1–6.
Mettler S, Mitchell N and Tipton KD (2010). Increased protein intake reduces lean body mass loss during weight loss in athletes. Med Sci Sports Exerc 42, 326–337.
Miller BF, Olesen JL, Hansen M, Dossing S, Crameri RM, Welling RJ, et al. (2005). Coordinated collagen and muscle protein synthesis in human patella tendon and quadriceps muscle after exercise. J Physiol 567, 1021–1033.
Moore DR, Robinson MJ, Fry JL, Tang JE, Glover EI, Wilkinson SB, et al. (2009). Ingested protein dose response of muscle and albumin protein synthesis after resistance exercise in young men. Am J Clin Nutr 89, 161–168.
Moran TH (2000). Cholecystokinin and satiety: current perspectives. Nutrition 16, 858–865.
Mountjoy PD and Rutter GA (2007). Glucose sensing by hypothalamic neurones and pancreatic islet cells: AMPle evidence for common mechanisms? Exp Physiol 92, 311–319.
Newsholme P, Gaudel C and McClenaghan NH (2010). Nutrient regulation of insulin secretion and beta-cell functional integrity. Adv Exp Med Biol 654, 91–114.
Nicklin P, Bergman P, Zhang B, Triantafellow E, Wang H, Nyfeler B, et al. (2009). Bidirectional transport of amino acids regulates mTOR and autophagy. Cell 136, 521–534.
Nilsson LH and Hultman E (1973). Liver glycogen in man–the effect of total starvation or a carbohydrate-poor diet followed by carbohydrate refeeding. Scand J Clin Lab Invest 32, 325–330.
Pasiakos SM, Vislocky LM, Carbone JW, Altieri N, Konopelski K, Freake HC, et al. (2010b). Acute energy deprivation affects skeletal muscle protein synthesis and associated intracellular signaling proteins in physically active adults. J Nutr 140, 745–751.
Pennings B, Boirie Y, Senden JM, Gijsen AP, Kuipers H and van Loon LJ (2011). Whey protein stimulates postprandial muscle protein accretion more effectively than do casein and casein hydrolysate in older men. Am J Clin Nutr 93, 997–1005.
Petersen KF, Dufour S, Savage DB, Bilz S, Solomon G, Yonemitsu S, et al. (2007). The role of skeletal muscle insulin resistance in the pathogenesis of the metabolic syndrome. Proc Natl Acad Sci U S A 104, 12587–12594.
Peyrollier K, Hajduch E, Blair AS, Hyde R and Hundal HS (2000). L-Leucine availability regulates phosphatidylinositol 3-kinase, p70 S6 kinase and glycogen synthase kinase-3 activity in L6 muscle cells: evidence for the involvement of the mammalian target of rapamycin (mTOR) pathway in the L-leucine-induced up-regulation of system A amino acid transport. Biochem J 350 Pt 2, 361–368.
Plaisancie P, Dumoulin V, Chayvialle JA and Cuber JC (1996). Luminal peptide YY-releasing factors in the isolated vascularly perfused rat colon. J Endocrinol 151, 421–429.
Ramnanan CJ, Edgerton DS, Kraft G and Cherrington AD (2011). Physiologic action of glucagon on liver glucose metabolism. Diabetes Obes Metab 13 Suppl 1, 118–125.
Rocha DM, Faloona GR and Unger RH (1972). Glucagon-stimulating activity of 20 amino acids in dogs. J Clin Invest 51, 2346–2351.
Rollo I and Williams C (2011). Effect of mouth-rinsing carbohydrate solutions on endurance performance. Sports Med 41, 449–461.
Sancak Y, Bar-Peled L, Zoncu R, Markhard AL, Nada S and Sabatini DM (2010). Ragulator-Rag complex targets mTORC1 to the lysosomal surface and is necessary for its activation by amino acids. Cell 141, 290–303.
Schwartz MW (2000). Biomedicine. Staying slim with insulin in mind. Science 289, 2066–2067.
Simpson KA, Martin NM and Bloom SR (2009). Hypothalamic regulation of food intake and clinical therapeutic applications. Arq Bras Endocrinol Metabol 53, 120–128.

Spanswick D, Smith MA, Mirshamsi S, Routh VH and Ashford ML (2000). Insulin activates ATP- sensitive K+ channels in hypothalamic neurons of lean, but not obese rats. Nat Neurosci 3, 757–758.
Strader AD and Woods SC (2005). Gastrointestinal hormones and food intake. Gastroenterology 128, 175–191.
Suzuki K, Simpson KA, Minnion JS, Shillito JC and Bloom SR (2010). The role of gut hormones and the hypothalamus in appetite regulation. Endocr J 57, 359–372.
Tanaka K, Inoue S, Nagase H and Takamura Y (1990). Modulation of arginine-induced insulin and glucagon secretion by the hepatic vagus nerve in the rat: effects of celiac vagotomy and administration of atropine. Endocrinology 127, 2017–2023.
Tang JE, Moore DR, Kujbida GW, Tarnopolsky MA and Phillips SM (2009a). Ingestion of whey hydrolysate, casein, or soy protein isolate: effects on mixed muscle protein synthesis at rest and following resistance exercise in young men. J Appl Physiol 107, 987–992.
Tipton KD, Ferrando AA, Phillips SM, Doyle D, Jr. and Wolfe RR (1999a). Postexercise net protein synthesis in human muscle from orally administered amino acids. Am J Physiol 276, E628–E634.
Vuksan V, Panahi S, Lyon M, Rogovik AL, Jenkins AL and Leiter LA (2009). Viscosity of fiber preloads affects food intake in adolescents. Nutr Metab Cardiovasc Dis 19, 498–503.
Walberg JL, Leidy MK, Sturgill DJ, Hinkle DE, Ritchey SJ and Sebolt DR (1988). Macronutrient content of a hypoenergy diet affects nitrogen retention and muscle function in weight lifters. Int J Sports Med 9, 261–266.
Wang GJ, Tomasi D, Backus W, Wang R, Telang F, Geliebter A, et al. (2008). Gastric distention activates satiety circuitry in the human brain. Neuroimage 39, 1824–1831.
Westerterp-Plantenga MS, Lemmens SG and Westerterp KR (2012). Dietary protein – its role in satiety, energetics, weight loss and health. Br J Nutr 108 Suppl 2, S105–S112.
Winder WW, Wilson HA, Hardie DG, Rasmussen BB, Hutber CA, Call GB, et al. (1997). Phosphorylation of rat muscle acetyl-CoA carboxylase by AMP-activated protein kinase and protein kinase A. J Appl Physiol 82, 219–225.
Winder WW, Holmes BF, Rubink DS, Jensen EB, Chen M and Holloszy JO (2000). Activation of AMP-activated protein kinase increases mitochondrial enzymes in skeletal muscle. J Appl Physiol 88, 2219–2226.
Yang Y, Breen L, Burd NA, Hector AJ, Churchward-Venne TA, Josse AR, et al. (2012). Resistance exercise enhances myofibrillar protein synthesis with graded intakes of whey protein in older men. Br J Nutr 1–9.
Yeo WK, Carey AL, Burke L, Spriet LL and Hawley JA (2011). Fat adaptation in well-trained athletes: effects on cell metabolism. Appl Physiol Nutr Metab 36, 12–22.
Zhang Y, Proenca R, Maffei M, Barone M, Leopold L and Friedman JM (1994). Positional cloning of the mouse obese gene and its human homologue. Nature 372, 425–432.

■ جهت مطالعه بیشتر

Abdul-Ghani MA and DeFronzo RA (2010). Pathogenesis of insulin resistance in skeletal muscle. J Biomed Biotechnol 2010, 476279.
Bramble DM and Lieberman DE (2004). Endurance running and the evolution of homo. Nature .432, 345–352.
Kahn SE, Hull RL and Utzschneider KM (2006). Mechanisms linking obesity to insulin resistance and type 2 diabetes. Nature 444, 840–846.
Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, et al. (2002). Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 346, 393–403.
Muoio DM and Newgard CB (2008). Mechanisms of disease: molecular and metabolic mechanisms of insulin resistance and beta-cell failure in type 2 diabetes. Nat Rev Mol Cell Biol 9, 193–205.
Rose AJ and Richter EA (2005). Skeletal muscle glucose uptake during exercise: how is it regulated? Physiology (Bethesda) 20, 260–270.

■ منابع

Abdul-Ghani MA and DeFronzo RA (2010). Pathogenesis of insulin resistance in skeletal muscle. J Biomed Biotechnol 2010, 476279.

Amati F, Dubé JJ, Alvarez-Carnero E, Edreira MM, Chomentowski P, Coen PM, et al. (2011). Skeletal muscle triglycerides, diacylglycerols, and ceramides in insulin resistance: another paradox in endurance-trained athletes? Diabetes 60, 2588–2597.

ADA (American Diabetes Association) (2013). Standards of medical care in diabetes – 2013. Diabetes Care 36 Suppl 1, S11–S66.

Archer E and Blair SN (2011). Physical activity and the prevention of cardiovascular disease: from evolution to epidemiology. Prog Cardiovasc Dis 53, 387–396.

Barker DJ (1997). Maternal nutrition, fetal nutrition, and disease in later life. Nutrition 13, 807–813.

Baur JA, Pearson KJ, Price NL, Jamieson HA, Lerin C, Kalra A, et al. (2006). Resveratrol improves health and survival of mice on a high-calorie diet. Nature 444, 337–342.

Bergstrom J and Hultman E (1966). Muscle glycogen synthesis after exercise: an enhancing factor localized to the muscle cells in man. Nature 210, 309–310.

Bersaglieri T, Sabeti PC, Patterson N, Vanderploeg T, Schanner SF, Drake JA, et al. (2004). Genetic signatures of strong recent positive selection at the lactase gene. Am J Hum Genet 74, 1111–1120.

Billings LK and Florez JC (2010). The genetics of type 2 diabetes: what have we learned from GWAS? Ann N Y Acad Sci 1212, 59–77.

Blair SN, Kampert JB, Kohl HW, III, Barlow CE, Macera CA, Pafenbarger RS, Jr., et al. (1996). Influences of cardiorespiratory fitness and other precursors on cardiovascular disease and all-cause mortality in men and women. JAMA 276, 205–210.

Boule NG, Weisnagel SJ, Lakka TA, Tremblay A, Bergman RN, Rankinen T, et al. (2005). Eects of exercise training on glucose homeostasis: the HERITAGE Family Study. Diabetes Care 28, 108–114.

Bramble DM and Lieberman DE (2004). Endurance running and the evolution of homo. Nature 432, 345–352.

Cerling TE, Wynn JG, Andanje SA, Bird MI, Korir DK, Levin NE, et al. (2011). Woody cover and hominin environments in the past 6 million years. Nature 476, 51–56.

Chakravarthy MV and Booth FW (2004). Eating, exercise, and "thrifty" genotypes: connecting the dots toward an evolutionary understanding of modern chronic diseases. J Appl Physiol 96, 3–10.

Cnop M, Foufelle F and Velloso LA (2011). Endoplasmic reticulum stress, obesity and diabetes. Trends Mol Med 18, 59–68.

Danaei G, Finucane MM, Lu Y, Singh GM, Cowan MJ, Paciorek CJ, et al. (2011). National, regional, and global trends in fasting plasma glucose and diabetes prevalence since 1980: systematic analysis of health examination surveys and epidemiological studies with 370 country-years and 2.7 million participants. Lancet 378, 31–40.

Danforth WH (1965). Glycogen synthetase activity in skeletal muscle. Interconversion of two forms and control of glycogen synthesis. J Biol Chem 240, 588–593.

DeFronzo RA, Ferrannini E, Sato Y, Felig P and Wahren J (1981). Synergistic interaction between exercise and insulin on peripheral glucose uptake. J Clin Invest 68, 1468–1474.

Diamond J (2003). the double puzzle of diabetes. Nature 423, 599–602.

Dolinoy DC (2008). the agouti mouse model: an epigenetic biosensor for nutritional and environmental alterations on the fetal epigenome. Nutr Rev 66 Suppl 1, S7–11.

Elia M (2000). Hunger disease. Clin Nutr 19, 379–386.

Ferrannini E, Barrett EJ, Bevilacqua S and DeFronzo RA (1983). Eect of fatty acids on glucose production and utilization in man. J Clin Invest 72, 1737–1747.

Finucane MM, Stevens GA, Cowan MJ, Danaei G, Lin JK, Paciorek CJ, et al. (2011). National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. Lancet 377, 557–567.

George S, Rochford JJ, Wolfrum C, Gray SL, Schinner S, Wilson JC, et al. (2004). A family with severe insulin resistance and diabetes due to a mutation in AKT2. Science 304, 1325–1328.

Gluckman PD, Hanson MA, Buklijas T, Low FM and Beedle AS (2009). Epigenetic mechanisms that underpin metabolic and cardiovascular diseases. Nat Rev Endocrinol 5, 401–408.

Goh KP and Sum CF (2010). Connecting the dots: molecular and epigenetic mechanisms in type 2 diabetes. Curr Diabetes Rev 6, 255–265.

Gollnick PD, Piehl K and Saltin B (1974). Selective glycogen depletion pattern in human muscle fibres after exercise of varying intensity and at varying pedalling rates. J Physiol 241, 45–57.

Gordon BA, Benson AC, Bird SR and Fraser SF (2009). Resistance training improves metabolic health in type 2 diabetes: a systematic review. Diabetes Res Clin Pract 83, 157–175.

Gresham D, Desai MM, Tucker CM, Jenq HT, Pai DA, Ward A, et al. (2008). e repertoire and dynamics of evolutionary adaptations to controlled nutrient-limited environments in yeast. PLoS Genet 4, e1000303.

Hansen PA, Gulve EA, Marshall BA, Gao J, Pessin JE, Holloszy JO and Mueckler M (1995). Skeletal muscle glucose transport and metabolism are enhanced in transgenic mice overexpressing the Glut4 glucose transporter. J Biol Chem 270, 1679–1684.

Hardie DG, Scott JW, Pan DA and Hudson ER (2003). Management of cellular energy by the AMP-activated protein kinase system. FEBS Lett 546, 113–120.

Hart GW, Slawson C, Ramirez-Correa G and Lagerlof O (2011). Cross talk between O-GlcNAcylation and phosphorylation: roles in signaling, transcription, and chronic disease. Annu Rev Biochem 80, 825–858.

Hill AM, Fleming JA and Kris-Etherton PM (2009). the role of diet and nutritional supplements in preventing and treating cardiovascular disease. Curr Opin Cardiol 24, 433–441.

Holloszy JO (2008). Regulation by exercise of skeletal muscle content of mitochondria and GLUT4. J Physiol Pharmacol 59 Suppl 7, 5–18.

Holloszy JO (2009). Skeletal muscle 'mitochondrial deficiency' does not mediate insulin resistance. Am J Clin Nutr 89, 463S–466S.

Houtkooper RH, Canto C, Wanders RJ and Auwerx J (2010). the secret life of NAD+: an old metabolite controlling new metabolic signaling pathways. Endocr Rev 31, 194–223.

Hu FB, Stampfer MJ, Solomon C, Liu S, Colditz GA, Speizer FE, et al. (2001). Physical activity and risk for cardiovascular events in diabetic women. Ann Intern Med 134, 96–105.

Hu FB, Li TY, Colditz GA, Willett WC and Manson JE (2003). Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. JAMA 289, 1785–1791.

Huang S and Czech MP (2007). the GLUT4 glucose transporter. Cell Metab 5, 237–252.

Hudson ER, Pan DA, James J, Lucocq JM, Hawley SA, Green KA, et al. (2003). A novel domain in AMP-activated protein kinase causes glycogen storage bodies similar to those seen in hereditary cardiac arrhythmias. Curr Biol 13, 861–866.

Isbell LA and Young TP (1996). the evolution of bipedalism in hominids and reduced group size in chimpanzees: alternative responses to decreasing resource availability. J Hum Evol 30, 289–297.

Kahn SE, Hull RL and Utzschneider KM (2006). Mechanisms linking obesity to insulin resistance and type 2 diabetes. Nature 444, 840–846.

Kahn SE, Zraika S, Utzschneider KM and Hull RL (2009). the beta cell lesion in type 2 diabetes: there has to be a primary functional abnormality. Diabetologia 52, 1003–1012.

Kennedy JW, Hirshman MF, Gervino EV, Ocel JV, Forse RA, Hoenig SJ, et al. (1999). Acute exercise induces GLUT4 translocation in skeletal muscle of normal human subjects and subjects with type 2 diabetes. Diabetes 48, 1192–1197.

Kim JK, Gavrilova O, Chen Y, Reitman ML and Shulman GI (2000). Mechanism of insulin resistance in A-ZIP/F-1 fatless mice. J Biol Chem 275, 8456–8460.

Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, et al. (2002). Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 346, 393–403.

Levy-Marchal C, Arslanian S, Cutfield W, Sinaiko A, Druet C, Marcovecchio ML, et al. (2010). Insulin resistance in children: consensus, perspective, and future directions. J Clin Endocrinol Metab 95, 5189–5198.

Lopez AD, Mathers CD, Ezzati M, Jamison DT and Murray CJ (2006). Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. Lancet 367, 1747–1757.

Lowell BB and Shulman GI (2005). Mitochondrial dysfunction and type 2 diabetes. Science 307, 384–387. Maarbjerg SJ, Sylow L and Richter EA (2011).

Current understanding of increased insulin sensitivity after exercise – emerging candidates. Acta Physiol (Oxford) 202, 323–335.

Manchester J, Skurat AV, Roach P, Hauschka SD and Lawrence JC, Jr. (1996). Increased glycogen accumulation in transgenic mice overexpressing glycogen synthase in skeletal muscle. Proc Natl Acad Sci U S A 93, 10707–10711.

Martin IK, Katz A and Wahren J (1995). Splanchnic and muscle metabolism during exercise in NIDDM patients. Am J Physiol 269, E583–E590.

Milne JC, Lambert PD, Schenk S, Carney DP, Smith JJ, Gagne DJ, et al. (2007). Small molecule activators of SIRT1 as therapeutics for the treatment of type 2 diabetes. Nature 450, 712–716.

Mootha VK, Lindgren CM, Eriksson KF, Subramanian A, Sihag S, Lehar J, et al. (2003). PGC- 1alpha-responsive genes involved in oxidative phosphorylation are coordinately downregulated in human diabetes. Nat Genet 34, 267–273.

Muoio DM and Newgard CB (2008). Mechanisms of disease: molecular and metabolic mechanisms of insulin resistance and beta-cell failure in type 2 diabetes. Nat Rev Mol Cell Biol 9, 193–205.

Myatt JP, Schilling N and thorpe SK (2011). Distribution patterns of fibre types in the triceps surae muscle group of chimpanzees and orangutans. J Anat 218, 402–412.

Narkar VA, Downes M, Yu RT, Embler E, Wang YX, Banayo E, et al. (2008). AMPK and PPARdelta agonists are exercise mimetics. Cell 134, 405–415.

Neel JV (1962). Diabetes mellitus: a “thrifty” genotype rendered detrimental by “progress”? Am J Hum Genet 14, 353–362. Neel JV (1999). the “thrifty genotype” in 1998. Nutr Rev 57, S2–S9.

O’Neill HM, Maarbjerg SJ, Crane JD, Jeppesen J, Jorgensen SB, Schertzer JD, et al. (2011). AMP- activated protein kinase (AMPK) beta1beta2 muscle null mice reveal an essential role for AMPK in maintaining mitochondrial content and glucose uptake during exercise. Proc Natl Acad Sci U S A 108, 16092–16097.

Patti ME, Butte AJ, Crunkhorn S, Cusi K, Berria R, Kashyap S, et al. (2003). Coordinated reduction of genes of oxidative metabolism in humans with insulin resistance and diabetes: Potential role of PGC1 and NRF1. Proc Natl Acad Sci U S A 100, 8466–8471.

Petersen KF and Shulman GI (2006). Etiology of insulin resistance. Am J Med 119, S10–S16.

Petrie JR, Pearson ER and Sutherland C (2011). Implications of genome wide association studies for the understanding of type 2 diabetes pathophysiology. Biochem Pharmacol 81, 471–477.

Prentice AM, Hennig BJ and Fulford AJ (2008). Evolutionary origins of the obesity epidemic: natural selection of thrifty genes or genetic drift following predation release? Int J Obes (Lond) 32, 1607–1610.

Randle PJ, Garland PB, Hales CN and Newsholme EA (1963). the glucose fatty-acid cycle. Its role in insulin sensitivity and the metabolic disturbances of diabetes mellitus. Lancet 1, 785–789.

Reasner CA and DeFronzo RA (2001). Treatment of type 2 diabetes mellitus: a rational approach based on its pathophysiology. Am Fam Physician 63, 1687–2, 1694.

Romijn JA, Coyle EF, Sidossis LS, Gastaldelli A, Horowitz JF, Endert E, et al. (1993). Regulation of endogenous fat and carbohydrate metabolism in relation to exercise intensity and duration. Am J Physiol 265, E380–E391.

Rose AJ and Richter EA (2005). Skeletal muscle glucose uptake during exercise: how is it regulated? Physiology (Bethesda) 20, 260–270.

Scholz MN, D’Aout K, Bobbert MF and Aerts P (2006). Vertical jumping performance of bonobo (Pan paniscus) suggests superior muscle properties. Proc Biol Sci 273, 2177–2184.

Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C and White RD (2006). Physical activity/ exercise and type 2 diabetes: a consensus statement from the American Diabetes Association. Diabetes Care 29, 1433–1438.

Singh U and Jialal I (2008). Alpha-lipoic acid supplementation and diabetes. Nutr Rev 66, 646–657.

Sinha R, Fisch G, Teague B, Tamborlane WV, Banyas B, Allen K, et al. (2002). Prevalence of impaired glucose tolerance among children and adolescents with marked obesity. N Engl J Med 346, 802–810.

Soares P, Alshamali F, Pereira JB, Fernandes V, Silva NM, Afonso C, et al. (2012). the expansion of mtDNA haplogroup L3 within and out of Africa. Mol Biol Evol 29, 915–927.

Speakman JR (2008). thrifty genes for obesity, an attractive but flawed idea, and an alternative perspective: the ‘drifty gene’ hypothesis. Int J Obes (Lond) 32, 1611–1617.

Stumvoll M, Goldstein BJ and van Haeften TW (2005). Type 2 diabetes: principles of pathogenesis and therapy. Lancet 365, 1333–1346.

Suwa M, Egashira T, Nakano H, Sasaki H and Kumagai S (2006). Metformin increases the PGC- 1alpha protein and oxidative enzyme activities possibly via AMPK phosphorylation in skeletal muscle in vivo. J Appl Physiol 101, 1685–1692.

the Wellcome Trust Case Control Consortium (2007). Genome-wide association study of 14,000 cases of seven common diseases and 3,000 shared controls. Nature 447, 661–678.

thomson DM and Winder WW (2009). AMP-activated protein kinase control of fat metabolism in skeletal muscle. Acta Physiol (Oxford) 196, 147–154.

Ungar PS and Sponheimer M (2011). the diets of early hominins. Science 334, 190–193.

Wang Y, Simar D and Fiatarone Singh MA (2009). Adaptations to exercise training within skeletal muscle in adults with type 2 diabetes or impaired glucose tolerance: a systematic review. Diabetes Metab Res Rev 25, 13–40.

Ward CV (2002). Interpreting the posture and locomotion of Australopithecus afarensis: where do we stand? Am J Phys Anthropol Suppl 35, 185–215.

Watt MJ, Heigenhauser GJ and Spriet LL (2002). Intramuscular triacylglycerol utilization in human skeletal muscle during exercise: is there a controversy? J Appl Physiol 93, 1185–1195.

Winder WW and Hardie DG (1999). AMP-activated protein kinase, a metabolic master switch: possible roles in type 2 diabetes. Am J Physiol 277, E1–10.

Witczak CA, Jessen N, Warro DM, Toyoda T, Fujii N, Anderson ME, et al. (2010). CaMKII regulates contraction- but not insulin-induced glucose uptake in mouse skeletal muscle. Am J Physiol Endocrinol Metab 298, E1150–E1160.

Xiao B, Sanders MJ, Underwood E, Heath R, Mayer FV, Carmena D, et al. (2011). Structure of mammalian AMPK and its regulation by ADP. Nature 472, 230–233.

Zhang BB, Zhou G and Li C (2009). AMPK: an emerging drug target for diabetes and the metabolic syndrome. Cell Metab 9, 407–416.

Zhou G, Myers R, Li Y, Chen Y, Shen X, Fenyk-Melody J, et al. (2001). Role of AMP-activated protein kinase in mechanism of metformin action. J Clin Invest 108, 1167–1174.

Zimmet P, Alberti KG and Shaw J (2001). Global and societal implications of the diabetes epidemic. Nature 414, 782–787.

■ جهت مطالعه بیشتر

Johnson SC, Rabinovitch PS and Kaeberlein M (2013). mTOR is a key modulator of ageing and agerelated disease. Nature 493, 338–345.

Narici MV and Maffulli N (2010). Sarcopenia: characteristics, mechanisms and functional significance. Br Med Bull. 95, 139–159

Powers SK and Jackson MJ (2008). Exercise-induced oxidative stress: cellular mechanisms and impact on muscle force production. Physiol Rev 88, 1243–1276.

Shawi M and Autexier C (2008). Telomerase, senescence and ageing. Mech Ageing Dev 129, 3–10.

Tyner SD, Venkatachalam S, Choi J, Jones S, Ghebranious N, Igelmann H, et al. (2002). p53 mutant mice that display early ageing-associated phenotypes. Nature 415, 45–53.

■ منابع

Aagaard P, Suetta C, Caserotti P, Magnusson SP and Kjaer M (2010). Role of the nervous system in sarcopenia and muscle atrophy with aging: strength training as a countermeasure. Scand J Med Sci Sports 20, 49–64.

Alsharidah M, Lazarus NR, George TE, Agley CC, Velloso CP and Harridge SD (2013). Primary human muscle precursor cells obtained from young and old donors produce similar proliferative, differentiation and senescent profiles in culture. Aging Cell 12, 333–344.

Anisimov VN, Berstein LM, Egormin PA, Piskunova TS, Popovich IG, Zabezhinski MA, et al. (2008). Metformin slows down aging and extends life span of female SHR mice. Cell Cycle 7, 2769–2773.

Baker DJ, Wijshake T, Tchkonia T, LeBrasseur NK, Childs BG, van de Sluis B, et al. (2011). Clearance of p16Ink4a-positive senescent cells delays ageing-associated disorders. Nature 479, 232–236.

Baur JA, Pearson KJ, Price NL, Jamieson HA, Lerin C, Kalra A, et al. (2006). Resveratrol improves health and survival of mice on a high-calorie diet. Nature 444, 337–342.

Blair SN and Morris JN (2009). Healthy hearts – and the universal benefits of being physically active: physical activity and health. Ann Epidemiol 19, 253–256.

Bodnar AG, Ouellette M, Frolkis M, Holt SE, Chiu CP, Morin GB, et al. (1998). Extension of life- span by introduction of telomerase into normal human cells. Science 279, 349–352.

Carlson ME, Hsu M and Conboy IM (2008). Imbalance between pSmad3 and Notch induces CDK inhibitors in old muscle stem cells. Nature 454, 528–532.

Carlson ME, Suetta C, Conboy MJ, Aagaard P, Mackey A, Kjaer M, et al. (2009). Molecular aging and rejuvenation of human muscle stem cells. EMBO Mol Med 1, 381–391.

Caron E, Ghosh S, Matsuoka Y, Ashton-Beaucage D, therrien M, Lemieux S, et al. (2010). A comprehensive map of the mTOR signaling network. Mol Syst Biol 6, 453.

Chakkalakal JV, Jones KM, Basson MA and Brack AS (2012). the aged niche disrupts muscle stem cell quiescence. Nature 490, 355–360.

Chen C, Liu Y, Liu Y and Zheng P (2009). mTOR regulation and therapeutic rejuvenation of aging hematopoietic stem cells. Sci Signal 2, ra75.

Cherkas LF, Hunkin JL, Kato BS, Richards JB, Gardner JP, Surdulescu GL, et al. (2008). the association between physical activity in leisure time and leukocyte telomere length. Arch Intern Med 168, 154–158. Christou DD and Seals DR (2008).

Decreased maximal heart rate with aging is related to reduced {beta}-adrenergic responsiveness but is largely explained by a reduction in intrinsic heart rate. J Appl Physiol 105, 24–29. Colman RJ, Anderson RM, Johnson SC, Kastman EK, Kosmatka KJ, Beasley TM, et al. (2009).

Caloric restriction delays disease onset and mortality in rhesus monkeys. Science 325, 201–204.

Conboy IM, Conboy MJ, Wagers AJ, Girma ER, Weissman IL and Rando TA (2005). Rejuvenation of aged progenitor cells by exposure to a young systemic environment. Nature 433, 760–764.

Cuthbertson D, Smith K, Babraj J, Leese G, Waddell T, Atherton P, et al. (2005). Anabolic signaling deficits underlie amino acid resistance of wasting, aging muscle. FASEB J 19, 422–424.

Ekblom B (1968). Effect of physical training on oxygen transport system in man. Acta Physiol Scand Suppl 328, 1–45.

Fisher-Wellman K and Bloomer RJ (2009). Acute exercise and oxidative stress: a 30 year history. Dyn Med 8, 1.

Frontera WR, Meredith CN, O'Reilly KP and Evans WJ (1990). Strength training and determinants of V . O 2max in older men. J Appl Physiol 68, 329–333.

Fullerton MD and Steinberg GR (2010). SIRT1 takes a backseat to AMPK in the regulation of insulin sensitivity by resveratrol. Diabetes 59, 551–553.

George T, Velloso CP, Alsharidah M, Lazarus NR and Harridge SD (2010). Sera from young and older humans equally sustain proliferation and differentiation of human myoblasts. Exp Gerontol 45, 875–881.

Gwinn DM, Shackelford DB, Egan DF, Mihaylova MM, Mery A, Vasquez DS, et al. (2008). AMPK phosphorylation of raptor mediates a metabolic checkpoint. Mol Cell 30, 214–226.

Harley CB, Futcher AB and Greider CW (1990). Telomeres shorten during ageing of human fibroblasts. Nature 345, 458–460.

Harman D (1956). Aging: A theory based on free radical and radiation chemistry. J Genrontol 11, 298–300.

Harrison DE, Strong R, Sharp ZD, Nelson JF, Astle CM, Flurkey K, et al. (2009). Rapamycin fed late in life extends lifespan in genetically heterogeneous mice. Nature 460, 392–395.

Hayflick L (1965). the limited in vitro lifetime of human diploid cell strains. Exp Cell Res 37, 614–636.

Herbert B, Pitts AE, Baker SI, Hamilton SE, Wright WE, Shay JW and Corey DR (1999). Inhibition of human telomerase in immortal human cells leads to progressive telomere shortening and cell death. Proc Natl Acad Sci U S A 96, 14276–14281.

Inoki K, Zhu T and Guan KL (2003). TSC2 mediates cellular energy response to control cell growth and survival. Cell 115, 577–590.

Jang YC, Lustgarten MS, Liu Y, Muller FL, Bhattacharya A, Liang H, et al. (2010). Increased superoxide in vivo accelerates age-associated muscle atrophy through mitochondrial dysfunction and neuromuscular junction degeneration. FASEB J 24, 1376–1390.

Jaskelioff M, Muller FL, Paik JH, omas E, Jiang S, Adams AC, et al. (2011). Telomerase reactivation reverses tissue degeneration in aged telomerase-deficient mice. Nature 469, 102–106.

Johnson SC, Rabinovitch PS and Kaeberlein M (2013). mTOR is a key modulator of ageing and age- related disease. Nature 493, 338–345.

Kanning KC, Kaplan A and Henderson CE (2010). Motor neuron diversity in development and disease. Annu Rev Neurosci 33, 409–440.

Kapahi P, Chen D, Rogers AN, Katewa SD, Li PW, thomas EL and Kockel L (2010). With TOR, less is more: a key role for the conserved nutrient-sensing TOR pathway in aging. Cell Metab 11, 453–465.

Kistler PM, Sanders P, Fynn SP, Stevenson IH, Spence SJ, Vohra JK, et al. (2004). Electrophysiologic and electroanatomic changes in the human atrium associated with age. J Am Coll Cardiol 44, 109–116.

Kumar V, Selby A, Rankin D, Patel R, Atherton P, Hildebrandt W, et al. (2009). Age-related differences in the dose-response relationship of muscle protein synthesis to resistance exercise in young and old men. J Physiol 587, 211–217.

Lagouge M, Argmann C, Gerhart-Hines Z, Meziane H, Lerin C, Daussin F, et al. (2006). Resveratrol improves mitochondrial function and protects against metabolic disease by activating SIRT1 and PGC-1alpha. Cell 127, 1109–1122.

Lauretani F, Russo CR, Bandinelli S, Bartali B, Cavazzini C, Di IA, et al. (2003). Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. J Appl Physiol 95, 1851–1860.

Lehmann M and Keul J (1986). Age-associated changes of exercise-induced plasma catecholamine responses. Eur J Appl Physiol Occup Physiol 55, 302–306.

Lexell J (1997). Evidence for nervous system degeneration with advancing age. J Nutr 127, 1011S–1013S.

Lexell J and Downham DY (1991). the occurrence of fibre-type grouping in healthy human muscle: a quantitative study of cross-sections of whole vastus lateralis from men between 15 and 83 years. Acta Neuropathol (Berl) 81, 377–381.

Lexell J, Taylor CC and Sjostrom M (1988). What is the cause of the ageing atrophy? Total number, size and proportion of different fiber types studied in whole vastus lateralis muscle from 15- to 83-year-old men. J Neurol Sci 84, 275–294.

Medvedev ZA (1990). An attempt at a rational classification of theories of ageing. Biol Rev Camb Philos Soc 65, 375–398.

Mittal KR and Logmani FH (1987). Age-related reduction in 8th cervical ventral nerve root myelinated fiber diameters and numbers in man. J Gerontol 42, 8–10.

Monfredi O, Dobrzynski H, Mondal T, Boyett MR and Morris GM (2010). the anatomy and physiology of the sinoatrial node – a contemporary review. Pacing Clin Electrophysiol 33, 1392–1406.

Moreland JD, Richardson JA, Goldsmith CH and Clase CM (2004). Muscle weakness and falls in older adults: a systematic review and meta-analysis. J Am Geriatr Soc 52, 1121–1129.

Narici MV and Maffulli N (2010). Sarcopenia: characteristics, mechanisms and functional significance. Br Med Bull 95, 139–159.

Pearl R (1928). the rate of living. University of London Press, London.

Ploutz-Snyder LL, Manini T, Ploutz-Snyder RJ and Wolf DA (2002). Functionally relevant thresholds of quadriceps femoris strength. J Gerontol A Biol Sci Med Sci 57, B144–B152.

Powers SK and Jackson MJ (2008). Exercise-induced oxidative stress: cellular mechanisms and impact on muscle force production. Physiol Rev 88, 1243–1276.

Rantanen T, Guralnik JM, Foley D, Masaki K, Leveille S, Curb JD, et al. (1999). Midlife hand grip strength as a predictor of old age disability. JAMA 281, 558–560.

Rasmussen BB, Fujita S, Wolfe RR, Mittendorfer B, Roy M, Rowe VL and Volpi E (2006). Insulin resistance of muscle protein metabolism in aging. FASEB J 20, 768–769.

Ristow M, Zarse K, Oberbach A, Kloting N, Birringer M, Kiehntopf M, et al. (2009). Antioxidants prevent health-promoting effects of physical exercise in humans. Proc Natl Acad Sci U S A 106, 8665–8670.

Rosen DR, Siddique T, Patterson D, Figlewicz DA, Sapp P, Hentati A, et al. (1993). Mutations in Cu/Zn superoxide dismutase gene are associated with familial amyotrophic lateral sclerosis. Nature 362, 59–62.

Rosenberg IH (1997). Sarcopenia: origins and clinical relevance. J Nutr 127, 990S–991S.

Ruiz JR, Sui X, Lobelo F, Morrow JR, Jr., Jackson AW, Sjostrom M, et al. (2008). Association between muscular strength and mortality in men: prospective cohort study. BMJ 337, a439.

Sanz A, Pamplona R and Barja G (2006). Is the mitochondrial free radical theory of aging intact? Antioxid Redox Signal 8, 582–599.

Selman C, Tullet JM, Wieser D, Irvine E, Lingard SJ, Choudhury AI, et al. (2009). Ribosomal protein S6 kinase 1 signaling regulates mammalian life span. Science 326, 140–144.

Shawi M and Autexier C (2008). Telomerase, senescence and ageing. Mech Ageing Dev 129, 3–10.

Shefner JM, Reaume AG, Flood DG, Scott RW, Kowall NW, Ferrante RJ, et al. (1999). Mice lacking cytosolic copper/

zinc superoxide dismutase display a distinctive motor axonopathy. Neurology 53, 1239–1246.

Shiraishi I, Takamatsu T, Minamikawa T, Onouchi Z and Fujita S (1992). Quantitative histological analysis of the human sinoatrial node during growth and aging. Circulation 85, 2176–2184.

Smith DL, Jr., Elam CF, Jr., Mattison JA, Lane MA, Roth GS, Ingram DK, et al. (2010). Metformin supplementation and life span in Fischer-344 rats. J Gerontol A Biol Sci Med Sci 65, 468–474.

Sohal RS and Buchan PB (1981). Relationship between physical activity and life span in the adult housefly, Musca domestica. Exp Gerontol 16, 157–162.

Speakman JR, Talbot DA, Selman C, Snart S, McLaren JS, Redman P, et al. (2004). Uncoupled and surviving: individual mice with high metabolism have greater mitochondrial uncoupling and live longer. Aging Cell 3, 87–95.

Tanaka H, Monahan KD and Seals DR (2001). Age-predicted maximal heart rate revisited. J Am Coll Cardiol 37, 153–156.

Teramoto M and Bungum TJ (2010). Mortality and longevity of elite athletes. J Sci Med Sport 13, 410–416. Tomlinson BE and Irving D (1977). the numbers of limb motor neurons in the human lumbosacral cord throughout life. J Neurol Sci 34, 213–219.

Trappe SW, Costill DL, Fink WJ and Pearson DR (1995). Skeletal muscle characteristics among distance runners: a 20-yr follow-up study. J Appl Physiol 78, 823–829.

Tyner SD, Venkatachalam S, Choi J, Jones S, Ghebranious N, Igelmann H, et al. (2002). p53 mutant mice that display early ageing-associated phenotypes. Nature 415, 45–53.

von Zglinicki T (2002). Oxidative stress shortens telomeres. Trends Biochem Sci 27, 339–344.

Weismann A (1892). Über Leben und Tod. Gustav Fischer, Jena. Wolfe RR (2006). the underappreciated role of muscle in health and disease. Am J Clin Nutr 84, 475–482.

Wu Y, Gao Z, Chen B, Koval OM, Singh MV, Guan X, et al. (2009). Calmodulin kinase II is required for fight or flight sinoatrial node physiology. Proc Natl Acad Sci U S A 106, 5972–5977.

■ جهت مطالعه بیشتر

Costa-Mattioli M, Sossin WS, Klann E and Sonenberg N (2009). Translational control of long-lasting synaptic plasticity and memory. Neuron 61, 10–211.

Kandel ER, Schwartz JH, Jessell TM and Hudspeth AJ (2012). Principles of neural science, 5th edn. McGraw-Hill, New York.

Kanning KC, Kaplan A and Henderson CE (2010). Motor neuron diversity in development and disease. Annu Rev Neurosci 33, 409–440.

Kim SJ and Linden DJ (2007). Ubiquitous plasticity and memory storage. Neuron 56, 582–592. Lomo T (2003). The discovery of long-term potentiation. Philos Trans R Soc Lond B Biol Sci 358, 617–620.

Mendell LM (2005). The size principle: a rule describing the recruitment of motoneurons. J Neurophysiol 93, 3024–3026.

■ منابع

Alvarez VA and Sabatini BL (2007). Anatomical and physiological plasticity of dendritic spines. Annu Rev Neurosci 30, 79–97.

Andrechek ER, Hardy WR, Girgis-Gabardo AA, Perry RL, Butler R, Graham FL, et al. (2002). ErbB2 is required for muscle spindle and myoblast cell survival. Mol Cell Biol 22, 4714–4722.

Arellano JI, Benavides-Piccione R, Defelipe J and Yuste R (2007). Ultrastructure of dendritic spines: correlation between synaptic and spine morphologies. Front Neurosci 1, 131–143.

Bliss TV and Lomo T (1973). Long-lasting potentiation of synaptic transmission in the dentate area of the anaesthetized rabbit following stimulation of the perforant path. J Physiol 232, 331–356.

Boecker H, Sprenger T, Spilker ME, Henriksen G, Koppenhoefer M, Wagner KJ, et al. (2008). The runner's high: opioidergic mechanisms in the human brain. Cereb Cortex 18, 2523–2531.

Burke RE, Levine DN, Tsairis P and Zajac FE, III (1973). Physiological types and histochemical profiles in motor units

of the cat gastrocnemius. J Physiol 234, 723–748.
Cajal R (1894). The Croonian lecture: la fine structure des centres nerveux. Proc R Soc Lond B Biol Sci 55, 444–468.
Chen HH, Hippenmeyer S, Arber S and Frank E (2003). Development of the monosynaptic stretch reflex circuit. Curr Opin Neurobiol 13, 96–102.
Collingridge GL, Kehl SJ and McLennan H (1983). The antagonism of amino acid-induced excitations of rat hippocampal CA1 neurons in vitro. J Physiol 334, 19–31.
Costa-Mattioli M, Gobert D, Stern E, Gamache K, Colina R, Cuello C, et al. (2007). eIF2alpha phosphorylation bidirectionally regulates the switch from short- to long-term synaptic plasticity and memory. Cell 129, 195–206.
Costa-Mattioli M, Sossin WS, Klann E and Sonenberg N (2009). Translational control of long-lasting synaptic plasticity and memory. Neuron 61, 10–26.
Courtine G, Bunge MB, Fawcett JW, Grossman RG, Kaas JH, Lemon R, et al. (2007). Can experiments in nonhuman primates expedite the translation of treatments for spinal cord injury in humans? Nat Med 13, 561–566.
Dalla Torre di Sanguinetto S, Dasen JS and Arber S (2008). Transcriptional mechanisms controlling motor neuron diversity and connectivity. Curr Opin Neurobiol 18, 36–43.
Flavell SW and Greenberg ME (2008). Signaling mechanisms linking neuronal activity to gene expression and plasticity of the nervous system. Annu Rev Neurosci 31, 563–590.
Foley TE and Fleshner M (2008). Neuroplasticity of dopamine circuits after exercise: implications for central fatigue. Neuromolecular Med 10, 67–80.
Fox PW, Hershberger SL and Bouchard TJ, Jr. (1996). Genetic and environmental contributions to the acquisition of a motor skill. Nature 384, 356–358.
Garcia-Campmany L, Stam FJ and Goulding M (2010). From circuits to behaviour: motor networks in vertebrates. Curr Opin Neurobiol 20, 116–125.
Gollnick PD, Piehl K and Saltin B (1974). Selective glycogen depletion pattern in human muscle fibres after exercise of varying intensity and at varying pedalling rates. J Physiol 241, 45–57.
Goulding M (2009). Circuits controlling vertebrate locomotion: moving in a new direction. Nat Rev Neurosci 10, 507–518.
Hagglund M, Borgius L, Dougherty KJ and Kiehn O (2010). Activation of groups of excitatory neurons in the mammalian spinal cord or hindbrain evokes locomotion. Nat Neurosci 13, 246–252.
Hebb DO (1949). Organization of behaviour: a neuropsychological theory. John Wiley, New York.
Jungblut S (2009). The correct interpretation of the size principle and its practical application to resistance training. Medicina Sportiva 13, 203–209.
Kanning KC, Kaplan A and Henderson CE (2010). Motor neuron diversity in development and disease. Annu Rev Neurosci 33, 409–440.
Karni A, Meyer G, Jezzard P, Adams MM, Turner R and Ungerleider LG (1995). Functional MRI evidence for adult motor cortex plasticity during motor skill learning. Nature 377, 155–158.
Kiehn O (2006). Locomotor circuits in the mammalian spinal cord. Annu Rev Neurosci 29, 279–306.
Kiehn O (2010). Development and functional organization of spinal locomotor circuits. Curr Opin Neurobiol 21, 100–109.
Kim SJ and Linden DJ (2007). Ubiquitous plasticity and memory storage. Neuron 56, 582–592.
Kullander K, Butt SJ, Lebret JM, Lundfald L, Restrepo CE, Rydstrom A, et al. (2003). Role of EphA4 and EphrinB3 in local neuronal circuits that control walking. Science 299, 1889–1892.
Lanuza GM, Gosgnach S, Pierani A, Jessell TM and Goulding M (2004). Genetic dentification of spinal interneurons that coordinate left-right locomotor activity necessary for walking movements. Neuron 42, 375–386.
Lee SJ, Escobedo-Lozoya Y, Szatmari EM and Yasuda R (2009). Activation of CaMKII in single dendritic spines during long-term potentiation. Nature 458, 299–304.
Lemon RN (2008). Descending pathways in motor control. Annu Rev Neurosci 31, 195–218.
Lisman J, Schulman H and Cline H (2002). The molecular basis of CaMKII function in synaptic and behavioural memory. Nat Rev Neurosci 3, 175–190.
Lomo T (1966). Frequency potentiation of excitatory synaptic activity in the dentate area of the hippocampal formation. Acta Physiol Scand 68, 128.
Lomo T (2003). The discovery of long-term potentiation. Philos Trans R Soc Lond B Biol Sci 358, 617–620.
London M and Hausser M (2005). Dendritic computation. Annu Rev Neurosci 28, 503–532.

Lynch GS, Dunwiddie T and Gribkoff V (1977). Heterosynaptic depression: a postsynaptic correlate of long-term potentiation. Nature 266, 737–739.

Lynch G, Larson J, Kelso S, Barrionuevo G, and Schottler F (1983). Intracellular injections of EGTA block induction of hippocampal long-term potentiation. Nature 305, 719–721.

Lynch MA (2004). Long-term potentiation and memory. Physiol Rev 84, 87–136.

Ma DK, Bonaguidi MA, Ming GL and Song H (2009). Adult neural stem cells in the mammalian central nervous system. Cell Res 19, 672–682.

Mendell LM (2005). The size principle: a rule describing the recruitment of motoneurons. J Neurophysiol 93, 3024–3026.

Missitzi J, Geladas N and Klissouras V (2004). Heritability in neuromuscular coordination: implications for motor control strategies. Med Sci Sports Exerc 36, 233–240.

Pereira AC, Huddleston DE, Brickman AM, Sosunov AA, Hen R, McKhann GM, et al. (2007). An in vivo correlate of exercise-induced neurogenesis in the adult dentate gyrus. Proc Natl Acad Sci U S A 104, 5638–5643.

Porter RS and Kaplan LS (2010). The Merck Manual, 19 edn. Merck Sharp & Dohme Corp., White house Station, New Jersey.

Rioult-Pedotti MS, Friedman D and Donoghue JP (2000). Learning-induced LTP in neocortex. Science 290, 533–536.

Sacktor TC (2011). How does PKMzeta maintain long-term memory? Nat Rev Neurosci 12, 9–15.

Schwartzkroin PA and Wester K (1975). Long-lasting facilitation of a synaptic potential following tetanization in the in vitro hippocampal slice. Brain Res 89, 107–119.

Shors TJ, Anderson ML, Curlik DM and Nokia MS (2011). Use it or lose it: How neurogenesis keeps the brain fit for learning. Behav Brain Res 227, 450–458.

Silva AJ, Stevens CF, Tonegawa S and Wang Y (1992). Deficient hippocampal long-term potentiation in alpha-calcium-calmodulin kinase II mutant mice. Science 257, 201–206.

Tang SJ, Reis G, Kang H, Gingras AC, Sonenberg N and Schuman EM (2002). A rapamycin-sensitive signaling pathway contributes to long-term synaptic plasticity in the hippocampus. Proc Natl Acad Sci U S A 99, 467–472.

Thompson AK, Chen XY and Wolpaw JR (2009). Acquisition of a simple motor skill: task-dependent adaptation plus long-term change in the human soleus H-reflex. J Neurosci 29, 5784–5792.

Tischmeyer W, Schicknick H, Kraus M, Seidenbecher CI, Staak S, Scheich H, et al. (2003). Rapamycin-sensitive signalling in long-term consolidation of auditory cortex-dependent memory. Eur J Neurosci 18, 942–950.

van Praag H (2009). Exercise and the brain: something to chew on. Trends Neurosci 32, 283–290.

von Kraus LM, Sacktor TC and Francis JT (2010). Erasing sensorimotor memories via PKMzeta inhibition. PLoS ONE 5, e11125.

Walmsley B, Hodgson JA and Burke RE (1978). Forces produced by medial gastrocnemius and soleus muscles during locomotion in freely moving cats. J Neurophysiol 41, 1203–1216.

Williams RW and Herrup K (1988). The control of neuron number. Annu Rev Neurosci 11, 423–453.

Xu T, Yu X, Perlik AJ, Tobin WF, Zweig JA, Tennant K, et al. (2009). Rapid formation and selective stabilization of synapses for enduring motor memories. Nature 462, 915–919.

Yu X and Zuo Y (2011). Spine plasticity in the motor cortex. Curr Opin Neurobiol 21, 169–174.

Zhang CL, Zou Y, He W, Gage FH and Evans RM (2008). A role for adult TLX-positive neural stem cells in learning and behaviour. Nature 451, 1004–1007.

■ منابع

Adam S, van Hall G, Osada T, Sacchetti M, Saltin B and Pedersen BK (2000). Production of interleukin-6 in contracting human skeletal muscles can account for the exercise-induced increase in plasma interleukin-6. J Physiol 529, 237–242.

Baum M, Muller-Steinhardt M, Liesen H and Kirchner H (1997). Moderate and exhaustive endurance exercise influences the interferon-gamma levels in whole-blood culture supernatants. Eur J Appl Physiol Occup Physiol 76, 165–169.

Beals KA and Manore MM (1994). the prevalence and consequences of subclinical eating disorders in female athletes.

Int J Sport Nutr 4, 175–195.
Bishop NC, Walker GJ, Gleeson M, Wallace FA and Hewitt CR (2009). Human T lymphocyte migration towards the supernatants of human rhinovirus infected airway epithelial cells: influence of exercise and carbohydrate intake. Exerc Immunol Rev 15, 127–144.
Boxer LA, Allen JM and Baehner RL (1980). Diminished polymorphonuclear leukocyte adherence. Function dependent on release of cyclic AMP by endothelial cells after stimulation of beta-receptors by epinephrine. J Clin Invest 66, 268–274.
Cai D, Frantz JD, Tawa NE, Jr, Melendez PA, Oh BC, Lidov HG, et al. (2004). IKKbeta/NF-kappaB activation causes severe muscle wasting in mice. Cell 119, 285–298.
Calder PC, Yaqoob P, thies F, Wallace FA and Miles EA (2002). Fatty acids and lymphocyte functions. Br J Nutr 87 Suppl 1, S31–S48.
Carey AL, Steinberg GR, Macaulay SL, thomas WG, Holmes AG, Ramm G, et al. (2006). Interleukin-6 increases insulin-stimulated glucose disposal in humans and glucose uptake and fatty acid oxidation in vitro via AMP-activated protein kinase. Diabetes 55, 2688–2697.
Chandra RK (1997). Nutrition and the immune system: an introduction. Am J Clin Nutr 66, 460S–463S.
Chinda D, Nakaji S, Umeda T, Shimoyama T, Kurakake S, Okamura N, et al. (2003). A competitive marathon race decreases neutrophil functions in athletes. Luminescence 18, 324–329.
Cuthbertson D, Smith K, Babraj J, Leese G, Waddell T, Atherton P, et al. (2005). Anabolic signaling deficits underlie amino acid resistance of wasting, aging muscle. FASEB J 19, 422–424.
de Craen AJ, Posthuma D, Remarque EJ, van den Biggelaar AH, Westendorp RG and Boomsma DI (2005). Heritability estimates of innate immunity: an extended twin study. Genes Immun 6, 167–170.
Doyle A, Zhang G, Abdel Fattah EA, Tony Eissa N and Li YP (2011). Toll-like receptor 4 mediates lipopolysaccharide-induced muscle catabolism via coordinate activation of ubiquitin-proteasome and autophagy-lysosome pathways. FASEB J 25, 99–110.
Dumke BR and Lees SJ (2011). Age-related impairment of T cell-induced skeletal muscle precursor cell function. Am J Physiol Cell Physiol 300, C1226–C1233.
Febbraio MA, Hiscock N, Sacchetti M, Fischer CP and Pedersen BK (2004). Interleukin-6 is a novel factor mediating glucose homeostasis during skeletal muscle contraction. Diabetes 53, 1643–1648.
Gleeson M, Bishop NC, Oliveira M and Tauler P (2011). Daily probiotic's (Lactobacillus casei Shirota) reduction of infection incidence in athletes. Int J Sport Nutr Exerc Metab 21, 55–64.
Gray P, Gabriel B, ies F and Gray SR (2012). Fish oil supplementation augments post-exercise immune function in young males. Brain Behav Immun 26, 1265–1272.
Heath GW, Ford ES, Craven TE, Macera CA, Jackson KL and Pate RR (1991). Exercise and the incidence of upper respiratory tract infections. Med Sci Sports Exerc 23, 152–157.
Heinz SA, Henson DA, Austin MD, Jin F and Nieman DC (2010). Quercetin supplementation and upper respiratory tract infection: A randomized community clinical trial. Pharmacol Res 62, 237–242.
Kappel M, Tvede N, Galbo H, Haahr PM, Kjaer M, Linstow M, et al. (1991). Evidence that the effect of physical exercise on NK cell activity is mediated by epinephrine. J Appl Physiol 70, 2530–2534.
Lancaster GI, Khan Q, Drysdale PT, Wallace F, Jeukendrup AE, Drayson MT, et al. (2005). Effect of prolonged exercise and carbohydrate ingestion on type 1 and type 2 T lymphocyte distribution and intracellular cytokine production in humans. J Appl Physiol 98, 565–571.
Li YP, Schwartz RJ, Waddell ID, Holloway BR and Reid MB (1998). Skeletal muscle myocytes undergo protein loss and reactive oxygen-mediated NF-NB activation in response to tumor necrosis factor D. FASEB J 12, 871–880.
Mitchell JB, Pizza FX, Paquet A, Davis BJ, Forrest MB and Braun WA (1998). Influence of carbohydrate status on immune responses before and after endurance exercise. J Appl Physiol 84, 1917–1925.
Moreira A, Delgado LS, Moreira P and Haahtela T (2009). Does exercise increase the risk of upper respiratory tract infections? Br Med Bull 90, 111–131.
Mourkioti F, Kratsios P, Luedde T, Song YH, Delafontaine P, Adami R, et al. (2006). Targeted ablation of IKK2 improves skeletal muscle strength, maintains mass, and promotes regeneration. J Clin Invest 116, 2945–2954.
Newsholme P, Curi R, Pithon Curi TC, Murphy CJ, Garcia C and Pires de Melo M (1999). Glutamine metabolism by lymphocytes, macrophages, and neutrophils: its importance in health and disease. J Nutr Biochem 10, 316–324.

Nieman DC, Nehlsen-Cannarella SL, Markoff PA, Balk-Lamberton AJ, Yang H, Chritton DB, et al. (1990). the effects of moderate exercise training on natural killer cells and acute upper respiratory tract infections. Int J Sports Med 11, 467–473.

Nieman DC, Miller AR, Henson DA, Warren BJ, Gusewitch G, Johnson RL, et al. (1994). Effect of high- versus moderate-intensity exercise on lymphocyte subpopulations and proliferative response. Int J Sports Med 15, 199–206.

Nieman DC, Buckley KS, Henson DA, Warren BJ, Suttles J, Ahle JC, et al. (1995). Immune function in marathon runners versus sedentary controls. Med Sci Sports Exerc 27, 986–992.

Nieman DC, Henson DA, Fagoaga OR, Utter AC, Vinci DM, Davis JM, et al. (2002). Change in salivary IgA following a competitive marathon race. Int J Sports Med 23, 69–75.

Nieman DC, Henson DA, McAnulty SR, Jin F and Maxwell KR (2009). n-3 polyunsaturated fatty acids do not alter immune and inflammation measures in endurance athletes. Int J Sport Nutr Exerc Metab 19, 536–546.

Northoff H and Berg A (1991). Immunologic mediators as parameters of the reaction to strenuous exercise. Int J Sports Med 12 Suppl 1, S9–15.

Oliveira M and Gleeson M (2010). the influence of prolonged cycling on monocyte Toll-like receptor 2 and 4 expression in healthy men. Eur J Appl Physiol 109, 251–257.

Ostrowski K, Hermann C, Bangash A, Schjerling P, Nielsen JN and Pedersen BK (1998). A trauma- like elevation of plasma cytokines in humans in response to treadmill running. J Physiol 513, 889–894.

Parry-Billings M, Budgett R, Koutedakis Y, Blomstrand E, Brooks S, Williams C, et al. (1992). Plasma amino acid concentrations in the overtraining syndrome: possible effects on the immune system. Med Sci Sports Exerc 24, 1353–1358.

Pedersen BK, Tvede N, Klarlund K, Christensen LD, Hansen FR, Galbo H, et al. (1990). Indomethacin in vitro and in vivo abolishes post-exercise suppression of natural killer cell activity in peripheral blood. Int J Sports Med 11, 127–131.

Pedersen BK, Helge JW, Richter EA, Rohde T and Kiens B (2000). Training and natural immunity: effects of diets rich in fat or carbohydrate. Eur J Appl Physiol 82, 98–102.

Peters EM and Bateman ED (1983). Ultramarathon running and upper respiratory tract infections. An epidemiological survey. S Afr Med J 64, 582–584.

Quinn LS, Anderson BG, Strait-Bodey L, Stroud AM and Argiles JM (2009). Oversecretion of interleukin-15 from skeletal muscle reduces adiposity. Am J Physiol 296, E191–202.

Robson PJ, Blannin AK, Walsh NP, Castell LM and Gleeson M (1999). Effects of exercise intensity, duration and recovery on in vitro neutrophil function in male athletes. Int J Sports Med 20, 128–135.

Rohde T, Asp S, MacLean DA and Pedersen BK (1998). Competitive sustained exercise in humans, lymphokine activated killer cell activity, and glutamine: an intervention study. Eur J Appl Physiol Occup Physiol 78, 448–453.

Rotter V, Nagaev I and Smith U (2003). Interleukin-6 (IL-6) induces insulin resistance in 3T3-L1 adipocytes and is, like IL-8 and tumor necrosis factor-alpha, overexpressed in human fat cells from insulin-resistant subjects. J Biol Chem 278, 45777–45784.

Scharhag J, Meyer T, Gabriel HH, Auracher M and Kindermann W (2002). Mobilization and oxidative burst of neutrophils are influenced by carbohydrate supplementation during prolonged cycling in humans. Eur J Appl Physiol 87, 584–587.

Simpson R, Florida-James G, Whyte G and Guy K (2006). the effects of intensive, moderate and downhill treadmill running on human blood lymphocytes expressing the adhesion/activation molecules CD54 (ICAM-1), CD18 (E2 integrin) and CD53. Eur J Appl Physiol 97, 109–121.

Simpson RJ, Florida-James GD, Whyte GP, Black JR, Ross JA, et al. (2007). Apoptosis does not contribute to the blood lymphocytopenia observed after intensive and downhill treadmill running in humans. Res Sports Med 15, 157–174.

Smith JA and Pyne DB (1997). Exercise, training, and neutrophil function. Exerc Immunol Rev 3, 96–116.

Starkie RL, Rolland J, Angus DJ, Anderson MJ and Febbraio MA (2001). Circulating monocytes are not the source of elevations in plasma IL-6 and TNF-alpha levels after prolonged running. Am J Physiol 280, C769–C774.

Steensberg A, Keller C, Starkie RL, Osada T, Febbraio MA and Pedersen BK (2002). IL-6 and TNF-alpha expression in, and release from, contracting human skeletal muscle. Am J Physiol 283, E1272–E1278.

Tabata I, Atomi Y and Miyashita M (1984). Blood glucose concentration dependent ACTH and cortisol responses to prolonged exercise. Clin Physiol 4, 299–307.

Tidball JG and Villalta SA (2010). Regulatory interactions between muscle and the immune system during muscle regeneration. Am J Physiol 298, R1173–R1187.

Toft AD, thorn M, Ostrowski K, Asp S, Moller K, Iversen S, et al. (2000). N-3 polyunsaturated fatty acids do not affect cytokine response to strenuous exercise. J Appl Physiol 89, 2401–2406.

Wallenius V, Wallenius K, Ahren B, Rudling M, Carlsten H, Dickson SL, et al. (2002). Interleukin- 6-deficient mice develop mature-onset obesity. Nat Med 8, 75–79.

Weidner TG, Cranston T, Schurr T and Kaminsky LA (1998). the effect of exercise training on the severity and duration of a viral upper respiratory illness. Med Sci Sports Exerc 30, 1578–1583.

West TE, Chierakul W, Chantratita N, Limmathurotsakul D, Wuthiekanun V, Emond MJ, et al. (2012). Toll-like receptor 4 region genetic variants are associated with susceptibility to melioidosis. Genes Immun 13, 38–46.