Fall 2006

California State University, Northridge
Department of Kinesiology

KIN 652 - Seminar in Exercise Physiology of Skeletal Muscle

Dr. Ben B. Yaspelkis, III
Office: RH 282
Office Hours: T 12:00-1:00 PM, Th 3:00-4:00 PM and by appointment
Office Phone: 818-677-7509
E-mail: ben.yaspelkis@csun.edu
http://www.csun.edu/~bby44411

Prerequisites: KIN 446/446L.

Course Objectives: This course will expose the student to advanced topics and theories in the physiological, anatomical, morphological and biochemical structure of skeletal muscle and adaptations that occur in skeletal muscle in response to exercise training.

Textbooks:

Jones, D., J. Round and A. de Haan. **Skeletal Muscle From Molecules to Movement**. Churchill Livingstone Edinburgh, UK, 2004. ISBN: 0-443-07427-5

Recommended Supplemental Texts

Houston, M.E. ***Biochemistry Primer for Exercise Science, Second Edition,*** Human Kinetics, 2001. ISBN: 073603644X

Brooks, G.A., T.D. Fahey, T.P. White and K.M. Baldwin. ***Exercise Physiology, Third Edition***, Mayfield, Mountain View, CA, 2000. ISBN: 0767410246

Course Schedule

Date	Topic

9/5 **Introduction**

- Hamilton, M.T. and F.W. Booth. Skeletal muscle adaptation to exercise: a century of progress. *J. Appl. Physiol.* 88: 327-331, 2000.

Section I

9/12 Ultrastructure of Skeletal Muscle

- SMMM, Chapter 1, 2, 3
- Eisenberg, B. R. Quantitative ultrastructure of mammalian skeletal muscle. *Handbook of Physiology: 10, Skeletal Muscle*. Chapter 3, pp. 73-112.
- Patel, T.J. and R.L Lieber. Force transmission in skeletal muscle: from actomyosin to external tendons. J.O. Holloszy (ed.) *Exercise and Sport Science Reviews.* Williams and Wilkens, 1997, Vol. 25, pp. 321-363.

9/19 **Motor Units, the Size Principle and Muscle Force**

- SMMM, Chapter 4, 5, 7
- Sale, D.G. Influence of exercise and training on motor unit activation. K.B. Pandolf (ed.) *Exercise and Sport Science Reviews.* Macmillan, New York, 1987, Vol. 15, pp. 95-151.

9/26 **Mechanics of Muscle Contraction and Mechanisms of Fatigue**

- SMMM, Chapter 9, 10
- Metzger, J. M. Mechanism of chemomechanical coupling in skeletal muscle during work. *Energy Metabolism in Exercise and Sport.* Brown and Benchmark, 1992, Vol 5, pp. 1 - 52.

10/3 **Regulation of Glycolysis and Mitochondrial Oxidation**

- SMMM, Chapter 6
- Tonkonogi, T. and K. Shalin. Physical exercise and mitochondrial function in human skeletal muscle. *Exerc. Sport. Sci Rev.* 30: 129-137, 2002.
- Crowther, G.J., M.F. Carey, W.F. Kemper and K.E. Conley. Control of glycolysis in contracting skeletal muscle. I. Turning it on. *Am. J. Physiol. Endocrinol. Metab.* 282: E67-E73, 2002.
- Crowther, G.J., W.F. Kemper, M.F. Carey, and K.E. Conley. Control of glycolysis in contracting skeletal muscle. I. Turning it off. *Am. J. Physiol. Endocrinol. Metab.* 282: E74-E79, 2002.
- Wilson, D.F. Factors affecting the rate and energetics of mitochondrial oxidative phosphorylation. *Med. Sci. Sports Exerc*. 26: 37-43, 1994.

10/10 **Adaptability of Skeletal Muscle: Aerobic Exercise Training**

- SMMM, Chapter 11
- Saltin, B. and P.D. Gollnick. Skeletal muscle adaptability: significance for metabolism and performance. *Handbook of Physiology: 10, Skeletal Muscle.* pp. 555-631.
- Hoppeler, H. and M. Fluck. Plasticity of skeletal muscle mitochondria: structure and function. *Med. Sci. Sports Exerc.* 35: 95-104, 2003.

10/17 **Aerobic Exercise-induced Intracellular Signals and Protein Expression in Skeletal Muscle**

- Holmes, B and G.L. Dohm. Regulation of GLUT4 gene expression during exercise. Med. Sci. Sport Exerc. 36: 1202-1206, 2004.
- Yaspelkis III, B. B., A.L. Castle, Z. Ding and J.L. Ivy. Attenuating the decline in ATP arrests the exercise training-induced increases in muscle GLUT4 and citrate synthase activity. *Acta Physiol, Scand.* 165: 71-80, 1999.
- Winder, W.W., B.F. Holmes, D.S. Rubnick, E.B. Jensen, M. Chen and J.O. Holloszy. Activation of AMP-activated protein kinase

increases mitochondrial enzymes in skeletal muscle. *J. Appl. Physiol.* 88: 2219-2226, 2000.

• Ojuka, E.O., T.E. Jones, D.H. Han, M. Chen, B. R. Wamhoff, M. Sturek and J.O. Holloszy. Intermittent increases in cytosolic Ca^{2+} stimulate mitochondrial biogenesis in muscle cells. *Am. J. Physiol. Endocrinol. Metab.* 283: E1040-E1045, 2002.

• Ojuka, E.O., T.E. Jones, L.A. Nolte, M. Chen, B.R. Wanhoff, M. Sturek and J.O. Holloszy. Regulation of GLUT4 biogenesis in muscle: evidence for involvement of AMPK and Ca^{2+}. *Am. J. Physiol. Endocrinol. Metab.* 282: E1008-E1013, 2001.

• Holmes, B.F., D.B. Lang, M.J. Birnbaum, J. Mu and G.L. Dohm. AMP kinase is not required for the GLUT4 response to exercise and denervation in skeletal muscle. *Am. J. Physiol. Endocrinol. Metab*. 287: 739-743, 2004.

10/24 MID- TERM EXAM

Section II –Topics and Articles

10/31 Skeletal Muscle Hypertrophy

• SMMM, Chapter 14

• Stewart, C.E.H. and J. Rittweger. Adaptive processes in skeletal muscle: Molecular regulators and genetic influences. *J. Musculoskelet. Neuronal Interact.* 6: 73-86, 2006.

• Fernandez, A.M., J. Dupont, R.P. Farrar, S. Lee, B. Stannard and D. LeRoith. Muscle specific inactivation of the IGF-I receptor induces compensatory hyperplasia in skeletal muscle. *J. Clin. Invest.* 109: 347-355, 2002.

• Sharma, M., B. Langley, J. Bass, R. Kambadur. Myostatin in muscle growth and repair. *Exerc. Sport Sci. Rev*. 29: 155-158, 2001.

• McNally, E.M. Poweful genes - Myostatin regulation of human muscle mass. *NEJM* 350: 2642-2644, 2004.

• Schulke, M., K.R. Wagner, L.E. Stolz, C. Hubner, T. Riebel, W. Komen, T. Braun, J. F. Tobin and S-J. Lee. Myostatin mutation associated with gross muscle hypertrophy in a child. *NEJM* 350: 2682-2688, 2004.

• Walker, K. S., R. Kambadur, M. Sharma and H.K. Smith. Resistance training alters plasma myostatin but not IGF-1 in healthy men. *Med. Sci. Sport Exerc.* 36: 787-793, 2004.

11/7 Carbohydrate Metabolism in Skeletal Muscle: Insulin Signaling and Glucose Transport

• Kido, Y., J. Nakae and D. Accili. Clinical Review 125: The insulin receptor and its cellular targets. *J. Clin. Endocrinol. Metabol*. 86: 972-979, 2001.

• Thong, F.S.L., C.B. Dugani and A. Klip. Turning signals on and off: GLUT4 traffic in the insulin-signaling highway. *Physiol*. 20: 271-284, 2005.

• Jessen N, and L.J. Goodyear. Contraction signaling to glucose transport in skeletal muscle. *J Appl Physiol.* 99: 330-337, 2005.

• Welsh, G. I., I. Hers, D.C. Berwick, G. Dell, M. Wherlock, R. Birkin, S. Leney and J. M. Tavare. Role of protein kinase B in insulin-regulated glucose uptake. *Biochem. Soc. Trans.* 33: 346-349, 2005.

• Farese, R.V. Function and dysfunction of aPKC isoforms for glucose transport in insulin-sensitive and insulin-resistant states. *Am. J. Physiol. Endocrinol. Metab.* 283: E1-E11, 2002.

11/14 Effects of Exercise Training on Skeletal Muscle Carbohydrate Metabolism

• Ivy, J.L., T.W. Zderic and D. L. Foght. Prevention and treatment of non-insulin-dependent diabetes mellitus. J.O. Holloszy (ed.) *Exercise and Sport Science Reviews.* Williams and Wilkens, 1999, Vol. 27, pp. 1-35.

• Zierath, J.R. Exercise training-induced changes in insulin-signaling in skeletal muscle. *J. Appl. Physiol.* 93: 773-781, 2002.

• Henriksen, E.J. Effects of acute exercise and exercise training on insulin-resistance. *J. Appl. Physiol.* 93: 788-796, 2002.

• Bernard, J.R., A.M. Crain, D.A. Rivas, H.H. Herr, D. W. Reeder and B.B. Yaspelkis III. Chronic aerobic exercise enhances classical and novel insulin signaling in Sprague Dawley rat skeletal muscle. *Acta. Physiol. Scand.* 183: 357-366, 2005.

• Yaspelkis III, B.B. Resistance training improves insulin signaling and action in skeletal muscle. *Exerc. Sport Sci Rev.* 34 (1): 42-46, 2006.

• Kirwan, J.P. and M. Jing. Modulation of insulin signaling in human skeletal muscle in response to exercise. *Exerc. Sport Sci. Rev.* 30: 85-90, 2002.

11/21 Defects in Skeletal Muscle Carbohydrate Metabolism

• Kahn, B.B. and J.S. Flier. Obesity and insulin resistance. *J. Clin. Invest.* 106: 473-481, 2000.

• Dresner, A.D., D. Laurent, M. Maruci, M.E. Griffin, S. Dufour, G.W. Cline, L.A. Slezak, D.K. Andersen, R. S. Hundal, D.L. Rothman, K.F. Petersen and G.I. Shulman, Effects of free fatty acids on glucose transport and IRS-1-associated phosphatidylinositol 3-kinase activity. *J. Clin. Invest.* 103: 253-259, 1999.

• Bruce, C.R. and J.A. Hawley. Improvements in insulin resistance with aerobic training: a lipocentric approach. *Med. Sci. Sport Exerc.* 36: 1196-1201, 2004.

• Singh, M.K., A.D. Krisan, A.M. Crain, D.E. Collins and B.B. Yaspelkis III. High-fat diet and leptin treatment alter skeletal muscle insulin-stimulated phosphatidylinositol 3-kinase activity and glucose transport. *Metabolism* 52 (9): 1196-1205, 2003.

• Herr, H.J., J.R. Bernard, D.W. Reeder, D.A. Rivas, J.J. Limon and B.B. Yaspelkis III. Insulin-stimulated plasma membrane association and activation of Akt2, aPKC ζ and aPKC λ in high fat fed rodent skeletal muscle. *J. Physiol.* 627-636, 2005.

• Shulman, G.I. Unraveling the cellular mechanism of insulin resistance in humans: new insights from magnetic resonance spectroscopy. *Physiol*. 19: 183-190, 2004.

11/28 Effects of Exercise on Skeletal Muscle Lipid Metabolism

• Achten, J. and A.E. Jeukendrup. Optimizing fat oxidation through exercise and diet. *Nutrition*. 20: 716-727, 2004.

• Turcotte, L.P. Muscle fatty acid uptake during exercise: possible mechanisms. *Exercise and Sport Science Reviews.* 28: 4-9, 2000.

• Spriet, L.L. Regulation of skeletal muscle fat oxidation during exercise in humans. *Med. Sci. Sport Exerc.* 34: 1477-1484, 2002.

• Watt, M.J., G.J.F. Heigenhauser and L.L. Spriet. Intramuscular triacylglycerol utilization in human skeletal muscle during exercise: is there a controversy? *J. Appl. Physiol*. 93: 1185-1195, 2002.

12/5 Skeletal Muscle Pain, Damage and Disease

• SMMM, Chapters 12, 15

• Proske, U. and T.J. Allen. Damage to skeletal muscle from eccentric exercise. *Exercise and Sport Science Reviews.* 33: 98-104, 2005.

12/12 General Topics

• Robergs, R.A., F. Ghiasvand and D. Parker. Biochemistry of exercise-induced metabolic acidosis. *Am. J. Physiol. Regul. Integr. Comp. Physiol.* 287: R502-R516, 2004.

• Abbiss, C.R. and P.B. Laursen. Models to explain fatigue during prolonged endurance cycling. *Sports Med.* 35: 865-898, 2005.

• A. Ross and M. Leveritt. Long-term metabolic and skeletal muscle adaptations to short-sprint training: implications for sprint training and tapering. Sports Med. 31: 1063-1082, 2001.

• Additional topics to be determined

12/19 Final Exam, 5:30 - 7:30 PM

GRADING

Mid Term	100 points
Final	100 points
Discussion Participation	50 points
Total	250

Grade Scale

A	94-100%	C	70-73
A-	89-93	C-	67-69
B+	84-88	D+	64-66
B	80-83	D	60-63
B-	77-79	D-	57-59
C+	74-76	F	<56

Exams: There will be a Mid-Term and Final each worth 100 points. The Mid-Term will cover material from the first 7 classes. The final will cover material from the second 6 classes.

Cheating: Any student caught cheating will automatically fail the course and may be subject to more severe University discipline.